IMPORT PRICE PASS-THROUGH INTO INFLATION INDICATORS IN TURKEY

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ABSTRACT

IMPORT PRICE PASS-THROUGH INTO
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This thesis analyzes the pass-through of external factors into consumer and producer prices in Turkey, with a special emphasis on import price pass-through. To this end, pricing along a distribution chain framework is utilized and it is estimated by Vector Auto Regression (VAR) in a sample period of April 2002 to March 2009. Results show that the pass-through of external shocks into producer prices is higher than it is for consumer prices. Compared with the results of previous studies, findings point out that the degree of pass-through has declined recently in Turkey. In addition, it is found that external factors had significant contribution to annual consumer inflation between 2006 and 2008. Nevertheless, even the contributions of external shocks are excluded, year-end inflation targets would not have been attained.

Keywords: Inflation, Pass-through, Import Prices, VAR Analysis

ÖZ

İTHAL FİYATLARININ TÜRKİYE'DE
ENFLASYON GÖSTERGELERİNE GEÇİŞKENLİĞİ

Yüncüler, Çağlar

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Bu çalışma, dışsal faktörlerin Türkiye'de tüketici ve üretici fiyatlarına geçişkenlik etkisini, ithal fiyatlarının geçişkenlik etkisine özel vurgu yaparak incelemektedir. Bu amaçla, bölüşüm zinciri fiyatlaması çerçevesi kullanılmış ve Vektör Oto Regresyon yöntemi ile Nisan 2002 – Mart 2009 arasında aylık veriler kullanılarak tahmin edilmiştir. Sonuçlar, dışsal faktörlerin üretici fiyatlarına geçişkenlik etkisinin tüketici fiyatlarına geçişkenlik etkisinden daha yüksek olduğunu; önceki çalışmaların sonuçlarıyla karşılaştırıldığında ise Türkiye'de geçişkenlik etkisinin geçmiş yıllara kıyasla azaldığını ortaya koymaktadır. Ayrıca, analiz sonuçları, 2006 ile 2008 yılları arasında dışsal faktörlerin yıllık tüketici enflasyonuna belirgin oranda katkı yaptığını, ancak bu katkılar hariç tutulduğunda bile enflasyon hedeflerinin tutturulamayacağını göstermektedir.

Anahtar Kelimeler: Enflasyon, İthal Fiyatları, Geçişkenlik, VAR Analizi

To My Family

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TABLE OF CONTENTS

LIST OF FIGURES

FIGURES

LIST OF TABLES

TABLES

CHAPTER 1

INTRODUCTION

High rates of inflation had been one of the major problems in Turkish economy for a long period of time beginning from 1970s to early 2000s. Especially, the extreme levels of annual inflation during 1990s clarified the unsustainable nature of high inflation levels. This put forward the necessity to bring inflation down to lower rates and the first major attempt was initiated at the end of 1999 by the introduction of an exchange rate-based stabilization program. However, the program collapsed with a deep economic crisis in February 2001. This development urged The Central Bank of the Republic of Turkey (CBRT) to pursue a new monetary policy regime. *"Inflation Targeting Regime"* (IT), supported with the floating exchange rate regime, emerged as a candidate to the new monetary policy regime in order to bring the long-lasting chronic inflation problem in Turkey to an end. But, the conditions just after the 2001 crisis did not allow implementing a complete IT program, as they would have limited the effectiveness of the monetary policy.[1] Accordingly, CBRT decided to pursue a gradual switch to sustain the preconditions for implementing an effective IT. *"Implicit Inflation Targeting Regime"* (IIT) was applied until 2006 as the transition period.[2] During this period, unfavorable conditions for IT improved. Following this, CBRT switched to *"Full-Fledged Inflation Targeting Regime"* (FFIT) in 2006 and continued with it since then. The basic motivation of FFIT was to maintain

[1] High inflation rate, deteriorated expectations due to the collapse of the fixed exchange rate regime, fiscal dominance, high risk premium of the country, high rates of dollarization summarize the conditions in the Turkish economy at the beginning of IT (Kara and Orak, 2008).

[2] IIT can be defined as the regime in which inflation targets are set and monetary policy instruments are used to hit these targets without announcing the adoption of IT officially. See Kara and Orak (2008) for details.

price stability by achieving low inflation rates. To this end, CBRT set year-end annual consumer inflation targets as 5, 4 and 4 percent, respectively, from 2006 to 2008.

The course of annual inflation began to display a downward trend just after the initiation of IT as the new monetary policy regime. During the IIT period, annual inflation fell from 68.5 percent at the beginning of 2002 to 7.7 percent in 2005. However, contrary to the expectations of CBRT, this achievement during IIT period did not continue into FFIT period.[3] The year-end annual inflations between 2006 and 2008 were higher than not only the pre-determined year-end inflation targets but also the 2005 annual inflation. In 2008, annual inflation rose as high as 12 percent, which was the highest level since 2004. The main reason was the external shocks that hit the Turkish economy in this period (Kara and Orak, 2008). In 2006, a sharp depreciation of Turkish Lira (TL) against US Dollar (USD) and in 2007 and 2008 the rise in import prices due to global conditions[4] had been effective on domestic prices. The extent of the latter shock was much higher than the former such that CBRT had to change the inflation targets set for 2009 and 2010.[5]

Turkey is an open economy and its integration to global economy has increased after 2001 crisis. As a consequent, one should expect inflation dynamics as well as all other variables in the economy to be affected directly by this openness of the economy. Just as, recent developments showed the vulnerability of Turkish economy to external shocks and the importance of

[3] More detailed information about inflation developments in IIT and FFIT periods are presented in Chapter 5.

[4] International commodity prices skyrocketed to record high levels in this period. As a result, most of the economies experienced the highest inflation levels since the oil price shock during 1970s. Average inflation rate doubled from 2 percent to 4 percent in developed economies and from 4 percent to approximately 8 percent in developing economies (Cecchetti and Moessner, 2008).

[5] In Monetary And Exchange Rate Policy for 2008 (CBRT), inflation targets were set as 4 percent for 2009 and 2010. In June 2008, CBRT changed the corresponding targets as 7.5 and 6.5, respectively.

external factors on domestic inflation dynamics. Therefore, it is important to analyze the extent of the relationship between external factors and inflation in order to implement an effective monetary policy. In this regard, hikes in annual inflation during 2007 and 2008 due to rising import prices constitute the main motivation of this study. The reason is that until 2007, exchange rate changes were more pronounced as the major external factor to affect inflation in Turkey but recent developments proved the importance of import prices in inflation. However, although there are studies on Turkish data that concentrate on exchange rate pass-through side of external shock effects (Leigh and Rossi, 2002; Alper, 2003; Arat, 2003; Arbatlı, 2003; Kara et al., 2007a; Kara and Öğünç, 2008), there has not been much attempt to identify import price pass-through into domestic prices due to global factors.[6]

This thesis analyzes the pass-through of external shocks into producer and consumer prices, with a special emphasis on import price pass-through.[7] In this way, it could be possible to make an evaluation on the extent of import price and exchange rate changes had affected inflation so far under IT. Besides, the results would enable to forecast consequences of a possible external shock on consumer and producer prices in the future. In this regard, this thesis presents valuable information on up to date pass-through dynamics in Turkey and findings can be used as a handy tool in the inflation analysis.

To investigate the pass-through effect, a monthly Vector Auto Regression (VAR) model is estimated in this thesis by using data between April 2002 and March 2009. The setup of the model is based on pricing along a distribution

[6] Lack of studies on import price pass-through is also notable in CBRT's reports. In 2006, CBRT quantified the impact of depreciation on inflation as 3.5 percentage points whereas in 2007 and 2008, CBRT just put the import price shock affected items on record notwithstanding a clear quantification.

[7] In this study, import price is used to mean import prices denominated in USD. Therefore, it gives information on international prices, as Turkey is a small and thus price-taker country in international trade.

chain framework as in McCarthy (2000). Two analytical tools are used to examine pass-through into prices. The first one is producing the impulse response functions, which provide information on the extent and the speed of the pass-through. The shocks are identified from the VAR residuals using the Cholesky decomposition. The pass-through coefficient in a given time period is calculated as the ratio of cumulative change in the price level to the cumulative change in the desired variable over the same period. The second tool is variance decomposition which identifies the relative importance of external shocks in explaining variations in prices.

This study also includes an analysis on the extent of the impact of external shocks on consumer inflation in Turkey based on the estimation results of the VAR model. By doing so, the contribution of exchange rate jump during May and June 2006 to 2006 inflation and the contribution of elevated import prices to 2007 and 2008 inflations are discussed. In this regard, the explanations of CBRT on overshooting the inflation targets for the respective years are evaluated. As the last remark, this study does not elaborate on exchange rate pass-through into import prices in order to keep the focus of the study on the pass-through into consumer and producer price indicators.

The results show that the cumulative pass-through of exchange rate and import prices into consumer prices is almost the same, although import price changes are reflected into prices quicker than exchange rate changes. On the other hand, the response of manufacturing industry producer prices to import price shocks is higher than it is for exchange rate. Variance decompositions signify that external shocks account for quite large fractions of the variance in all price indices. Compared with the results of the previous studies, findings point out that the degree of pass-through has declined recently in Turkey. In addition, calculations based on the information derived from impulse response functions conclude that external shocks had sizable impact on 2006, 2007 and 2008 annual inflation. However, even the

contributions of external shocks are excluded; none of the year-end inflation would have hit the targets in FFIT period.

The outline of this thesis is as follows: Chapter 2 explains the theory of pass-through and the associated literature on pass-through. Chapter 3 covers the specification of the model. In this regard, the data, the setup and identification of the model are introduced. In addition, the residuals tests are presented before the estimation results. In Chapter 4, the empirical results of the estimated model are presented. The results of impulse response functions, variance decomposition, sensitivity of results to different Cholesky ordering and the comparison of results with previous studies are covered. Chapter 5 presents the exercise on the impact of external shocks on realized inflation rates between 2006 and 2008 based on the results given in Chapter 4. Finally, Chapter 6 presents a brief summary of the findings and concluding remarks.

CHAPTER 2

THE THEORY AND EMPIRICS OF PASS-THROUGH

This chapter presents a summary of the pass-through theory and the associated literature on pass-through. In Section 2.1, the transmission mechanism and the factors determining the extent and speed of pass-through are discussed. In Section 2.2, pass-through literature is reviewed with emphasis on import price pass-through studies. In addition, pass-through literature on Turkish data is overviewed.

2.1 The Theory of Pass-Through

The transmission mechanism between an external shock and consumer prices may show up in various channels. Some changes are passed-through almost directly. This may be observed in items in the consumption basket such as petroleum, natural gas, and solid fuels, because especially small countries are price-takers for these products in the global market and the changes are reflected directly to the domestic economies. The shocks can also have indirect effects on prices through changes in production costs of firms, which are generally reflected on retail prices through mark-up channel. These direct and indirect effects are named first-round effects.

Another channel of pass-through arises if first-round effects mentioned above spill over into inflation perception of economic agents. If an external shock increases the public's longer-term inflation expectations, this would put additional upward pressure on inflation, accordingly (Bernanke, 2006). These reflections are generally observed on items, which are not directly related to

the initial shock.[8] These types of indirect effects are called second-round effects.

According to Law of One Price, with perfect competition and no impediments to trade, arbitrage behavior would ensure that the domestic price of any traded good (P_d) is equal to the foreign price (P_f) of an identical good multiplied by the nominal exchange rate (e) (Equation 2.1).

$$P_d = eP_f \qquad [2.1]$$

In this framework, a change in the nominal exchange rate or the foreign prices should be reflected on the domestic prices one-to-one. Such situation is called complete pass-through. However, in practice, this is almost never observed. There may be several factors for the pass-through to be incomplete. A vast theoretical and empirical literature exists to explain incompleteness of pass-through by several different factors/channels:

The first factor is the size of the economy. The conventional wisdom had long been that in a large country, the inflationary effect of currency depreciation or import price shock on domestic prices is expected to be lower than that in a small economy. The rationale is that a rise in prices will be counteracted by a fall in world prices through lower world demand, thus, reducing the pass-through effect, whereas a small country would have no effect on international price of the good, which leads to a higher pass-through (McCarthy, 2000). More recent studies, on the other hand, have shown that the evidence on sizable difference in the degree of pass-through between small and large countries is not so clear or less than expected (Frankel et al., 2005; Murray, 2008).

[8] A possible example may be education services item in the consumption basket. Although, it does not have a direct relationship with external factors, change in general outlook of inflation may alter its pricing behavior through expectations.

As another factor, the characteristic of the shock may influence the measured pass-through. If the shock displays non-volatile and persistent characteristic, then willingness of firms to reflect such a shock onto their prices increases. Otherwise, if the shocks are perceived to be volatile or temporary, then, firms prefer to make adjustment on their profit margins instead of reflecting them on domestic prices. Shortly, the greater the persistency and lower the volatility of the external shocks, the higher the degree of pass-through is (Taylor, 2000).

Taylor (2000) suggests one more rationalization for possible changes in measured pass-through. He claims that a lower inflation environment, e.g sustained due to a new monetary policy regime, may involve a lower pass-through by a reduction in the expected persistence of shocks. Choudri and Hakura (2001) and Devereux and Yetman (2002) find evidence on systematic variation of estimated pass-through with the average inflation rate. They find that in countries where inflation rates are considerably high, the pass-through coefficients are high as well.

Firms' mark-up pricing strategy stands as another factor. The behavior of mark-ups is affected not only by persistency or volatility of the shocks, but also any factor effective in firms' pricing strategy. Usually industrial organization models are used to explain such additional factors. Dornbusch (1985) and Krugman (1987) provide leading examples of such models. Especially, Krugman's (1987) "pricing-to-market"[9] concept is the most pronounced feature and is considered to be an important factor for an incomplete pass-through. Goldberg and Knetter (1997) find that pass-through is smaller in more segmented industries. This demonstrates that as the concentration in a sector decrease, the power of firms to pass through the shocks into their prices increases. Import penetration is another determining

[9] It is the idea that in international markets with imperfect competition, foreign firms adjust their mark-ups differently considering the market conditions in different countries and fail to reflect changes in external factors in their prices (Arbatlı, 2003).

factor in that sense, since an industry having a larger import share is more prone to reflect shocks on its prices. All these factors influencing the pricing strategy determine whether the firms are more responsive to short term fluctuations or longer-term movements, which in turn determines the extent and speed of the pass-through.

The degree of the substitutability of the imported goods in the domestic market is another factor (Burstein, Eichenbaum and Rebelo, 2002). If the imported good has a domestic substitute, regardless of it being a final or intermediate good, the pass-through is smaller, as firms and consumers are eager to buy the cheaper domestic goods. However, this may not realize if a common factor increases both the international and domestic price simultaneously. Therefore, relative price difference and the degree of substitutability become more important in such cases.

One last channel on the relationship between imported and domestic prices is offered by McCarthy (2000). He argues that pass-through is expected to fall along a distribution chain. This generally stems from the structure of the price indicators. That is to say, consumer prices contain more non-traded items such as administered prices and services while producer prices comprise of more traded goods. In addition, tax burden is also higher on consumer prices compared to producer prices. Therefore, as fraction of items affected by external shocks decreases along the distribution chain, the degree of pass-through falls.

To conclude, external factors affect domestic prices in both direct and indirect ways. However, the degree of how external shocks are transmitted to prices depends on some factors. The size of the economy, the volatility and the persistency of shocks, the inflationary environment, the substitutability of imported goods, the structure of the distribution chain and factors influential in firms' pricing strategy, i.e. market concentration, pricing-to-market effects, the degree of import penetration can be classified as major ones. After the

theory of pass-through is summarized, an overview of empirical studies developed on this theory is presented.

2.2 A Synopsis on the Empirics of Pass-Through

In general, the pass-through literature falls on one of the two categories: The first category consists of studies trying to determine the pass-through of exchange rate to import prices. These studies can be at both micro and macro level. Explicitly, it may examine the pass-through of exchange rate into import price either at industry level (Irandoust, 2000; Pollard and Coughlin, 2004) or for the whole economy (Campa and Goldberg, 2002). The second category includes studies estimating the pass-through of external shocks, i.e. exchange rate and import prices, into price indicators such as consumer price index, wholesale price index and producer price index (McCarthy, 2000; Hahn, 2003).

Having been motivated to analyze the import price pass-through into inflation indicators, rather than exchange rate pass-through, it would be useful to present a brief summary of studies focusing on import price pass-through effects at this point.[10] Following the variation in theory, empirical studies show some variation in terms of the methodology they use.

The mark-up pricing framework, in which consumer prices are represented as a mark-up over producer prices, provides insight for one effective methodology. In such models, import prices are taken as a component of the unit cost of production.[11] Hampton (2001) is an example to this framework. In his study for New Zealand, he regresses consumer prices on import price,

[10] The literature focusing on import price pass-through is fairly limited compared to the literature focusing on exchange rate pass-through.

[11] Therefore, the method incorporates only the indirect effects and rules out the direct effects of import prices on consumer prices.

unit labor cost and output gap using monthly data. Employing a co-integration model, he tries to identify long-run relationship between import prices and consumer prices. He finds that a 10 percent increase in import prices lead to 1.5 percent increase in consumer prices.

The two-step approach can be considered as an extension of the mark-up pricing framework. The method initially requires the estimation of pass-through of import prices into producer prices and, then, pass-through from producer prices to consumer prices. After the estimates of the two steps are retrieved, they are combined to calculate the import price pass-through into consumer inflation. In a recent study, Liu and Tsang (2008) investigate pass-through effect of global commodity prices on China's inflation.[12] The study finds that in a three-month period, a 10 percent increase in international commodity prices lead to 1.2 percent rise in producer prices and 0.24 percent rise in consumer prices.

Among the analyses of import price pass-through on domestic inflation indicators, one of the most employed methods is the *"pricing along the distribution chain"*. One of the most cited studies in this framework is McCarthy (2000). This study examines the pass-through of both exchange rates and import prices to domestic inflation in 9 industrialized countries.[13] To this end, it utilizes "a VAR model that permits one to track pass-through from external shocks to each stage of the distribution chain in a simple integrated framework" (p.2). The impulse response functions indicate that import price shocks have a larger effect than exchange rate shocks on domestic inflation in most of the countries. He also finds that pass-through is higher in countries where import share of domestic demand is higher and external shocks are more persistent.

[12] This study uses monthly data between July 2005 and May 2008.

[13] The countries in this study are the United States, Japan, Germany, France, the United Kingdom, Belgium, the Netherlands, Sweden, and Switzerland.

There are vast numbers of studies employing the methodology of McCarthy (2000). However, the set of variables may differ due to the specification of each study. One such study belongs to Hahn (2003) in which he investigates pass-through of external shocks on Euro Area inflation. He finds that pass-through is largest and fastest for non-oil import price shocks. Exchange rate shocks and oil price shocks follow. Another example is Duma (2008) in which pass-through of external shocks to consumer inflation in Sri Lanka is examined. He finds 40 percent exchange rate pass-through in a period of 4 months and 28 percent import price pass-through in a period of 3 months.

The pass-through studies on Turkish economy are limited in number and most of them use models similar models to McCarthy (2000).[14] Leigh and Rossi (2002) is one example, which analyzes exchange rate pass-through in Turkey between 1994 and 2002. They find that in a period of 1 year about 60 percent of the initial shock is passed through to wholesale prices, whereas pass-through into consumer prices is 45 percent.

Arat (2003) and Arbatlı (2003) are two other studies utilizing VAR framework to analyze exchange rate pass-through in Turkey. Following Leigh and Rossi (2002), these studies also focus on a sample period dominated by pre-2001 data. Arat (2003) finds that exchange rate pass-through into inflation takes longer time than the one Leigh and Rossi (2002) calculates. In addition, pass-through into non-tradable goods is much smaller than that into tradable goods. Arbatlı (2003) extends the study by utilizing a threshold VAR model to examine asymmetries in the relationship between exchange rate and inflation. She concludes that the asymmetry is significant and pass-through into prices is lower during significant economic contractions, periods with higher exchange rate depreciation and periods with lower inflation.

[14] All studies on Turkish economy that are presented here focus on exchange rate pass-through into domestic prices.

There are also pass-through studies on Turkish data utilizing a single-equation framework. In one such study, Alper (2003) investigates exchange rate pass-through in Turkey by applying a single equation error-correction mechanism model and computes the pass-through coefficient through recursive estimates. Kara et al. (2007a) on the other hand, try to identify the relation between different exchange rate regimes and the pass-through in a time-varying setup. Results derived from single equation models are almost similar to results obtained from VAR models.

One of the most recent studies investigating pass-through in Turkey is Kara and Öğünç (2008). The methodology used in this study is also based on McCarthy (2000). However, unlike other studies analyzing Turkish pass-through, they focus on pass-through of imported inflation into price indicators, rather than just looking at exchange rate pass-through. Besides, using the advantage of employing a more recent data set, they compare pass-through effects between pre-2001 and post-2001 periods. They conclude pass-through had fallen with the introduction of IT and flexible exchange rate regimes after 2001.

CHAPTER 3

THE MODEL AND METHODOLOGY

This chapter presents the data, the model and the methodology to analyze the pass-through into price indicators. In this regard, Section 3.1 summarizes the data selection process. Given the data selection, Section 3.2 presents the setup of the model chosen to analyze the pass-through effects into price indicators and the identification of it. Section 3.3 gives specification of the VAR methodology.

3.1 The Data

The specification of a proper model for a pass-through analysis needs a proper selection of variables and determination of the time series properties of the data. In Section 3.1.1, the data selection process is presented. In Section 3.1.2 the data properties are discussed.

3.1.1 The Data Set

The choice of the variables for the pass-through analysis is based on the considerations regarding the aim of the study and the pricing model which is presented in detail in Section 3.2.

The analysis aims to identify the pass-through of external shocks into prices. Therefore, variables defining such a transmission have to be included in the model. The pricing model defines this transmission mechanism by stages along a distribution chain which captures importer, producers and

consumers. In this regard, price indicators reflecting consumer, producer and import prices have to take place in the model. On the other hand, the study by Karadaş et al. (2008) shed some light on selection of further variables by examining the factors affecting pricing behavior of the Turkish manufacturing industry. According to the study, demand conditions, exchange rate developments and cost changes are listed as the main determinants of Turkish firms' monthly price revisions.[15] This implies that the model should also include variables representing demand and the exchange rate.[16]

In the literature, there are several proxies to represent demand shocks into the economy such as output gap, industrial production index (IPI) and capacity utilization rate (CUR). This study necessitates an indicator reflecting the demand dynamics of the aggregate economy as it aims to make a pass-through analysis at the broadest level possible. Indicators such as IPI and CUR are good at reflecting conditions of the industrial sector, which is only one part of the economy.[17] However, output gap captures the dynamics of all sectors in the economy. Therefore, output gap is the choice for representing the demand dynamics.

Yet, output gap is, by definition, an abstract notion.[18] It is not directly observed and therefore, has to be estimated. There are several estimation techniques for estimating output gap in the literature. In this thesis, output gap is estimated from the quarterly national accounts data with a time-varying parameter methodology by exploiting extended Kalman Filter

[15] This can be considered as a justification of using a monthly model instead of a quarterly model.

[16] Import prices also serve for the cost component of the production.

[17] According to National Accounts data provided by Turkish Statistical Institute (TURKSTAT), industrial sector comprises approximately 26 percent of Gross Domestic Product (GDP) as of 2008.

[18] Output gap is defined as the logarithmic difference between actual GDP and the potential GDP.

technique in a multivariate setting, as presented in Kara et al. (2007b).[19] The estimated quarterly output gap is transformed into monthly data following the methodology suggested by Fernandez (1981).[20]

The exchange rate variable is selected as the monthly average of nominal TL to USD rate. Using TL/USD rate instead of other exchange rates depends on some rationale: First of all, majority of Turkish import is carried out in USD terms.[21] This implies that the value of USD against TL is more important for economic activity than any other exchange rate. Secondly, value of USD may have a higher influence on expectations and on inflation perception due to the inertia originating from the era of fixed exchange rate regime.

To represent import prices, unit value of import price index in USD terms is preferred. This ensures measuring impact of import price shocks on inflation that result from global conditions. Besides, it backs the selection of TL/USD rate as the exchange rate variable. In this way, the exchange rate and import price variables in the model are harmonized.

The manufacturing industry producer price index is chosen to represent production side. It is plausible to use this indicator because manufacturing industry carries out most of the imports in Turkey.[22] In addition, as of 2009 manufacturing industry's weight in whole producer price index (PPI) is 73.75 percent; therefore, it reflects the general characteristics of producer-side in Turkey.

[19] According to Kara et al. (2007b), estimating the output gap in this setting may have many advantages over univariate techniques such as the Hodrick-Prescott (HP) filter.

[20] According to Fernandez (1981), the output gap data can be transformed into monthly frequency using the seasonally adjusted capacity utilization rate of industrial sector. After the calculations, the average of monthly output gap data at each quarter is equal to the output gap data estimated for that quarter.

[21] In 2008, 63 percent of import agreements were denominated in USD (TURKSTAT).

[22] As of 2008, manufacturing industry carried out 75 percent of imports (TURKSTAT).

The final step is to choose a consumer price indicator. Consumer price index (CPI)[23] and core inflation indicators[24] are the most used indicators in the literature. The main difference between using core inflation and CPI is that core inflation indicators rule out the direct effects and reflect indirect effects. This thesis aims to encompass both direct and indirect effects of import price changes on consumer prices. Therefore, CPI is the choice for representing consumer prices.[25] Besides its conceptual advantage, the communication of CPI with public is easier than that of core indicators (Mishkin, 2007). This makes the analysis a better policy tool.

The analysis is based on monthly data covering the time period April 2002 to March 2009. There are several reasons to make such a selection. First of all, this study aims to be a useful tool for the policy makers and this necessitates a sample size that reflects recent macroeconomic conditions of the economy. In this regard, one needs to cover the IT period. Secondly, this sample period allows for a better detection of the impact of import prices on domestic prices, because changes in import prices are more pronounced in this period, while influence of exchange rate has lost power with the floating exchange rate regime. In addition, this sample period gives better pass-through results as it eliminates observations distorted by 2001 crisis.

[23] Headline inflation is also used in the literature to mean CPI.

[24] Core inflation is a measure of inflation that excludes certain items in the consumption basket. The definition of core inflation may differ among countries. In Turkey, there are 9 core inflation indicators published officially by TURKSTAT under the title Special Consumption Aggregates.

[25] CPI shows significant seasonal characteristic. To eliminate it, the CPI series is seasonally adjusted using Tramo/Seats. However, seasonal adjustment is not performed over a unique series, as there are two different base-year indices in the sample period, which show different seasonality (Atuk, 2009). To handle this, the data before and after 2004 is seasonally adjusted separately and combined thereafter.

3.1.2 The Data Properties

The unit root tests are undertaken to evaluate the time series properties of the selected variables. The results of these tests are summarized in Table 3.1.1. Augmented Dickey Fuller (ADF) test reports that nominal exchange rate, import prices, manufacturing industry PPI and CPI are non-stationary in levels, but stationary in first differences, suggesting that they are integrated of order 1, I(1). Output gap is, by definition, a stationary variable, I(0).

Table 3.1.1 Unit Root Test of Variables[26]

Variables	ADF Statistic	Order of Integration
Exchange Rate	-5.017	I(1)
Import Prices	-4.340	I(1)
Manufacturing Industry PPI	-5.141	I(1)
CPI	-2.983	I(1)

One should note that there is a discussion whether variables should be differenced or not, even if they contain a unit root. Sims (1980) and Sims, Stock and Watson (1990) argue that taking differences lead to information loss, such as a possible cointegrating relationship. To assess the existence of such relatişonship between variables, Johansen cointegration test is conducted. The results indicate that there is no strong evidence for a significant cointegrating relationship between variables. This avoids the possibility of information loss in the model. Hence, all variables except output gap enter the model in first differences, whereas output gap enters in levels.[27]

[26] Unit root tests were performed on variables expressed in logarithms. The lag lengths were chosen automatically to minimize Akaike Information Criteria (AIC). The ADF Statistics presented are significant at 5 percent significance level according to ADF distribution's critical values.

[27] According to Enders (2004), there are three advantages of using differenced variables in a VAR model. First, it assures the impulse responses be consistent estimates of the true responses. Second, tests gain power as you estimate n^2 less parameters, where n is number of variables. Third, you can use standard F-distribution to test for Granger causality.

3.2 The Model

This study uses a model of pricing along a distribution chain as in McCarthy (2000) to examine pass-through effects into inflation indicators. One shall focus on the reasons on the choice of this framework before future discussing the details of the model.

Following a similar method to McCarthy (2000) has its own advantages compared to its alternatives discussed in Chapter 2: First of all, pricing along a distribution chain framework allows one to observe how external shocks are transmitted from one distribution stage to another. Secondly, unlike its alternatives, the model allows import price shocks to affect domestic consumer inflation both directly and indirectly through their effects on producer inflation.[28] Thirdly, it incorporates the dynamics through pricing power and changing mark-up rates.[29]

As presented in Section 3.1, five variables are selected to include into the model. Given the stationarity analyses results, the variables are the first difference of the logarithm of nominal exchange rate, the first difference of the logarithm of import prices denominated in USD[30], the first difference of the logarithm of manufacturing industry PPI, the first difference of the logarithm of CPI and the output gap. Each of these 5 variables will correspond to one stage of the distribution chain.

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[28] Both mark-up and two-step approach frameworks only allows measuring the indirect effects of import prices on consumer inflation, since import prices take place in the model only as a cost factor in the production process. However, import prices may have direct effects on consumer inflation too.

[29] Mark-up framework assumes a constant mark-up over producer prices even if the conditions in the economy change over time. However, as also mentioned in Chapter 2, firms may have an incentive to change their profit margins by adjusting their mark-up rates amid factors such as market competition, demand conditions in the economy and the type of external shock they are exposed to.

[30] It will be named shortly as import prices thereafter.

In pricing along a distribution chain, inflation at each stage, i.e. producer and consumer inflations, consists of six components. The first component is the expected inflation at that stage. The expectations are based on the available information at the period t-1. The second component is the domestic demand shock at period t. The third and fourth components are exchange rate and import price shocks at period t. Next component are the shocks at the previous stages of the chain.[31] Finally, there is the shock that belongs to that stage. Therefore, the particular shock of each stage is the part of the inflation at that stage that cannot be explained by shocks of previous stages of the distribution chain and information at period t-1. Under the conditions presented so far, the pricing model can be written in the following manner:

$$gap_t = E_{t-1}(gap_t) + \varepsilon_t^{gap} \quad [3.1]$$

$$\Delta e_t = E_{t-1}(\Delta e_t) + \alpha_1 \varepsilon_t^{gap} + \varepsilon_t^{\Delta e} \quad [3.2]$$

$$\pi_t^{imp} = E_{t-1}(\pi_t^{imp}) + \beta_1 \varepsilon_t^{gap} + \beta_2 \varepsilon_t^{\Delta e} + \varepsilon_t^{imp} \quad [3.3]$$

$$\pi_t^{manu} = E_{t-1}(\pi_t^{manu}) + \delta_1 \varepsilon_t^{gap} + \delta_2 \varepsilon_t^{\Delta e} + \delta_3 \varepsilon_t^{imp} + \varepsilon_t^{manu} \quad [3.4]$$

$$\pi_t^{cpi} = E_{t-1}(\pi_t^{cpi}) + \gamma_1 \varepsilon_t^{gap} + \gamma_2 \varepsilon_t^{\Delta e} + \gamma_3 \varepsilon_t^{imp} + \gamma_4 \varepsilon_t^{manu} + \varepsilon_t^{cpi} \quad [3.5]$$

where gap_t is the output gap; Δe_t is the first difference of the logarithm of nominal exchange rate; π_t^{imp}, π_t^{manu} and π_t^{cpi} are the first difference of the logarithm of import prices, manufacturing industry PPI and CPI, respectively. ε_t^{gap} represents demand shock; $\varepsilon_t^{\Delta e}$ is the shock to the nominal exchange rate and ε_t^{imp} is the import price shock. ε_t^{manu} and ε_t^{cpi} represent shocks to manufacturing industry PPI and CPI, respectively. The shocks are assumed to be serially uncorrelated and orthogonal across equations. Finally, E_{t-1} (.) refers to the expectation of the variable based on the information set available at the end of period t-1.

[31] This refers to the producer inflation shock that exists at consumer inflation stage.

In this model, it is assumed that the demand shocks onto the Turkish economy are directly identified from the dynamics of the output gap. Exchange rate shocks are identified from the dynamics of exchange rate depreciation after taking into account the contemporaneous effect of demand shocks. Import price shocks are identified from the unit value of imports after taking into account the contemporaneous effect of both demand and exchange rate shocks. Finally, the price measures contain sequential shocks that can be attributed to the various stages of distribution chain. One should note that there is no contemporaneous feedback in the model, i.e. consumer prices affects variables in previous stages of the chain through its effect on expected inflation in later periods. The specification of the model allows import price shocks to affect consumer prices both directly and indirectly. In addition, shocks contain information about factors that affect pricing power of firms. This model, unlike McCarthy (2000), does not include a separate equation to account for supply shocks.[32] However, import prices contain information about oil prices, as Turkey is highly dependent on oil imports. Therefore, along with exchange rate variable, the model includes a supply shock implicitly.[33]

The model in this study closely relates to Kara and Öğünç (2008), but presents some extension over it. In Kara and Öğünç (2008), there is only one variable to account for external shocks, which is TL-denominated import prices - a composite variable comprising exchange rates and import prices. This means that the transmission mechanism and the impact of these two components on prices are supposed to be the same. This may lead to loss of information in the analysis, since exchange rate and import prices may affect inflation through different dynamics, as well as the speed and the extent of these reflections may be dissimilar. For this reason, the composite variable in

[32] McCarthy (2000) uses oil price inflation denominated in local currency to account for supply side.

[33] Monetary side of the economy is also excluded in this study.

Kara and Öğünç (2008) is decomposed into two and each component is inserted into the model separately in this thesis.

Turning back to the setup of the model, the structure of the equations suggests that they are part of a recursive VAR framework. Given this structure of the model, if conditional expectations in equations [3.1] to [3.5] are replaced by linear projections of the lags of the five endogenous variables in the system, one can estimate this model as a VAR.

Identification of the shocks of such model is achieved by applying Cholesky decomposition. Cholesky decomposition imposes restrictions which is necessary to identify the structural VAR model that links the reduced form and the structural residuals (Hahn, 2003). Economically, these restrictions imply that some of the structural shocks do not have a contemporaneous impact on some of the variables. Therefore, economic interpretation is obtained through the ordering of the variables, as it specifies which shocks are not allowed to contemporaneously affect which variables.

The ordering of variables in the baseline model is taken as output gap, nominal exchange rate, import prices, manufacturing industry PPI and CPI. The output gap is ranked first in the ordering which reflects the presumption that output gap innovations at monthly frequency are primarily driven by exogenous factors and other variables could affect it only through expectations channel in the future periods. Concerning inflation, the pricing chain from trade prices to producer prices and from producer prices to retail consumer prices motivates the ordering. Lastly, positioning of exchange rate between price indicators and the output gap is based on the assumption that it may be affected by current overall demand conditions of the economy and

may contemporaneously affect import prices as exchange rate and import prices may change simultaneously amid global conditions.[34]

Estimating the model as a VAR and utilizing Cholesky decomposition allows one to identify shocks and to analyze impulse responses of inflation indicators to these shocks. This, in turn, makes possible to observe not just the magnitude of the pass-through but also the speed of it.[35] However, to estimate the VAR model, some tests have to be conducted.

First of all, an appropriate lag length has to be selected. It is important because, although adding more lags to the model increases the power of fit, it reduces the degrees of freedom and may cause the over-fitting problem, given the small sample size. Conversely, limiting the lag length may lead to model misspecification. After determining the lag length, residuals tests have are conducted. These include investigation of autocorrelation, normality, heteroskedasticity, stability and stationarity properties of the model.[36] An ideal VAR model has to pass these tests. After confirming that there is no problem in residual diagnostics, impulse response functions can be utilized to analyze the extent and the speed of pass-through of external factors into both consumer prices and manufacturing industry producer prices. In this way, the empirical results obtained from this analysis can be used as a tool in inflation analyses.[37]

[34] An alternative ordering would place the output gap between import prices and manufacturing industry producer prices. In such a design, exchange rate and import prices contemporaneously affect output gap. However, whether output gap is so sensitive to such shocks or not is open to discussion. To determine the robustness of the results, a comparison between the baseline model and this alternative ordering is discussed in detail in Section 4.4. To preview the results, the robustness analysis shows that results do not change significantly when ordering of the variables changes.

[35] It also facilitates to compare the results of this thesis with other studies, since most of the pass-through analysis for Turkey is based on this modeling.

[36] The detailed analysis of lag length selection and the residual tests are presented in Section 3.3.

[37] The results of impulse response functions are presented in Section 4.1.

3.3 VAR Model Specification

3.3.1 Lag Length Selection

There are several criteria to select the optimal lag length for the VAR model.[38] Sequential Likelihood Ratio test (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SC) and Hannan-Quinn Information Criterion (HQ) are such examples. Enders (2004) claims that setting an upper limit while testing for the appropriate lag length is beneficial. This upper limit is $T^{1/3}$, where T is the number of observation.[39] In this case, it corresponds to 5.[40]

Table 3.3.1 VAR Lag Length Selection Criteria[41]

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1174.13		7.11E-19	-27.59	-27.16	-27.42
1	1301.76	230.94	6.19E-20	-30.04	-28.88*	-29.57*
2	1334.28	54.98*	5.23e-20*	-30.22*	-28.34	-29.46
3	1355.39	33.17	5.86E-20	-30.12	-27.52	-29.08
4	1371.90	23.97	7.45E-20	-29.92	-26.59	-28.58
5	1396.45	32.74	8.00E-20	-29.91	-25.86	-28.28
6	1419.82	28.37	9.10E-20	-29.87	-25.10	-27.95
7	1450.27	33.34	9.11E-20	-30.00	-24.50	-27.79
Wald Lag Exclusion Test						
	Output Gap	Dlog(e)	Dlog(imp)	Dlog(manu)	Dlog(cpi)	Joint
Lag 1	99.99	15.08	28.02	28.95	24.41	186.24
	[0.000]	[0.009]	[0.000]	[0.000]	[0.000]	[0.000]
Lag 2	12.59	11.06	2.07	13.02	8.41	46.44
	[0.027]	[0.050]	[0.839]	[0.023]	[0.134]	[0.005]
Lag 3	15.43	3.56	4.85	5.59	4.09	36.59
	[0.008]	[0.613]	[0.433]	[0.347]	[0.536]	[0.063]

[38] For a detailed analysis on VAR lag order selection, see Ivanov and Kilian (2002).

[39] Enders (2004) states that in case of a suspicion of substantial amount of seasonality, the number of lags could be extended beyond $T^{1/3}$. For our model, only variable that shows seasonality is CPI and as mentioned in Section 3.1.1 it is seasonally adjusted. Therefore, we can stick to the rule suggested by Enders (2004).

[40] For a monthly VAR, starting with 18-24 lags for lag length selection can be suggested for large samples. However, in this case, it is non-applicable due to the limited number of observations.

[41] * indicates the lag order selected by the criteria. Numbers in brackets are p-values

Table 3.3.1 presents the results of VAR lag length selection criteria. The majority of criteria report 2 as the optimal lag length, whereas SC and HQ select 1. However, SC is known to be more conservative about selecting lag length. Thus, using 2 lags in the VAR model seems reasonable. Similarly, Wald test concludes that second lags in the model are jointly significant while the third lags are jointly insignificant at 5 percent significance level. Therefore, the optimal lag length for the VAR model is chosen as 2. This finding is in line with the expectations that transmission mechanism among the variables is supposed to be working rather quickly.

3.3.2 Residual Tests

The residual graphs illustrate that there are some outliers disturbing residual diagnostics.[42] Two dummy variables for June 2006 and October 2008 are included into the model to improve these disturbed diagnostics to some extent.[43] The results of the residual tests under these conditions are presented in Table 3.3.2. As expected, after these two dummy variables are included into the model, residual tests give better results.

[42] See Appendix Figure A.1.

[43] June 2006 corresponds to the month when exchange rate jumped rapidly due to a global financial turmoil. October 2008 is the month when the so-called 2008 World economic crisis hit the Turkish economy.

Table 3.3.2 Residual Tests of VAR

Serial Correlation Test[44]		
Lags	LM-Stat	Probability
1	37.50428	0.0517
2	21.62811	0.6571
3	31.41935	0.1755
4	16.63936	0.8945
5	18.15817	0.8356
6	30.07094	0.2216

Normality Test[45]						
	Skewness		Kurtosis		Jarque-Bera	
Component	Value	Probability	Value	Probability	Value	Probability
3.1	0.355498	0.1835	2.758855	0.6519	1.972836	0.3729
3.2	0.618054	0.0207	2.775397	0.6743	5.524424	0.0632
3.3	-0.119633	0.6544	1.805137	0.0254	5.197313	0.0744
3.4	0.024575	0.9267	1.853132	0.0319	4.612024	0.0997
3.5	-0.14186	0.5956	2.022157	0.0673	3.628358	0.163
Joint		0.1792		0.0205		0.0216

Heteroskedasticity Test[46]			
With Cross Terms		No Cross terms	
Chi Square	Probability	Chi Square	Probability
1018.02	0.38	318.3498	0.667

LM test reports that there is no autocorrelation problem in the VAR model. This implies that the specification of the VAR with lag length of 2 is sufficient to eliminate auto-correlation problem and there is no need to change the lag length. As for the normality of residuals, it is not rejected at 5 percent significance level for any equation. Thus, normality is also satisfied. However, the residuals seem to have Kurtosis problem. This can be attributed to the highly erratic structure of variables. Thirdly, heteroskedasticity tests are conducted. The residuals are found to satisfy homoskedasticity. These three tests show that the residuals of the VAR model pass basic diagnostic tests.

[44] Null Hypothesis: No serial correlation at lag order h. Probabilities are from chi-square with 25 degrees of freedom.

[45] The numbers under component column correspond to the numbers of the equations of the model, presented in Section 3.2.

[46] Null Hypothesis: No heteroskedasticity.

Stationarity of residuals is as important as stationarity of variables. If the residuals are non-stationary, it is not possible to get impulse responses that decay as time passes on. In fact, since the variables included in the model are stationary, residuals are expected to be stationary too. The results of the unit root test of VAR residuals confirm this expectation (Table 3.3.3).

Table 3.3.3 Unit Root Test of VAR Residuals

Residual of Equation	ADF Statistic	Order of Integration
Output Gap	-9.92289	I(0)
Exchange Rate	-8.67165	I(0)
Import Prices	-9.73445	I(0)
Manufacturing Industry PPI	-8.5758	I(0)
CPI	-9.15986	I(0)

On the other hand, ensuring the stability of the system is of crucial importance for the analysis. All roots of characteristic polynomial are found to lie inside the unit circle. Therefore, the VAR is stable. Stability of the system and stationarity of the residuals confirm that impulse response functions can be used to examine the pass-through of external shocks into price indicators.

CHAPTER 4

THE EMPIRICAL RESULTS

This chapter presents and discusses the empirical results derived from the VAR model. In this regard, in Section 4.1, impulse response functions of manufacturing industry producer prices and consumer prices to each external shock are presented. In Section 4.2, variance decomposition is utilized to assess the relative importance of exchange rate and import prices for variation in price indicators. Section 4.3 presents an analysis on robustness of results to change in the ordering of variables. In the last section, the results are compared with the results of previous studies utilizing Turkish data.

4.1 Impulse Response Functions

The impulse response functions of the VAR model are estimated over a 24-month horizon. The shocks to the system are orthogonalized using Cholesky decomposition. All shocks are standardized to one percent shocks. As a result, in the figures presenting pass-through results, the vertical axis indicates the approximate percentage point change in the respective price indicator due to a one percent shock in the respective variable. In other words, it indicates percentage of the pass-through.[47]

As in Kara and Öğünç (2008), the pass-through coefficient in a given time period is calculated as the ratio of cumulative change in the price level to the

[47] The impulse response function graphs, which are presented in the Appendix, show responses to a one standard deviation shock. The dotted lines in the figures given in Appendix are two standard error bands of the impulse response functions.

cumulative change in the desired variable over the same period.[48] These coefficients illustrate the model's predicted adjustment of prices to an external shock after accounting disturbances of the other endogenous variables in the model (Leigh and Rossi, 2002).

4.1.1 Impulse Responses to Import Price Shock

Figure 4.1.1 and Figure 4.1.2 display the impulse response of consumer and manufacturing industry producer prices following a one percent shock to import prices. As the main focus is on pass-through to price indicators, other responses are not reported here.[49] In this model, the import price shock is estimated given past values of all endogenous variables in addition to current values of output gap and exchange rate.

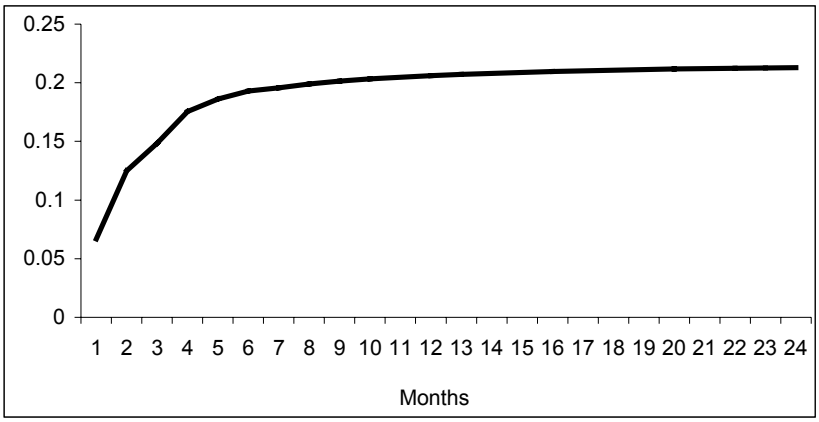

Figure 4.1.1 Impulse Response of Consumer Prices to Import Price Shock

[48] The formal representation is in following manner: $PT_{t,t+j} = P_{t,t+j}/E_{t,t+j}$, where $P_{t,t+j}$ denotes the cumulative change in the price level and $E_{t,t+j}$ is the cumulative change in the variable whose pass-through will be calculated.

[49] Impulse responses of all endogenous variables to import price shocks are presented in Appendix, Figure A.2.

The responses of consumer and producer prices to a one percent increase in import prices are positive and statistically significant, as expected. For consumer prices, the pass-through amounts to around 21 percent after 1 year and nearly stable thereafter. As for manufacturing industry prices, pass-through is 46 percent at the end of the first year and accumulates to 50 percent after 2 years.

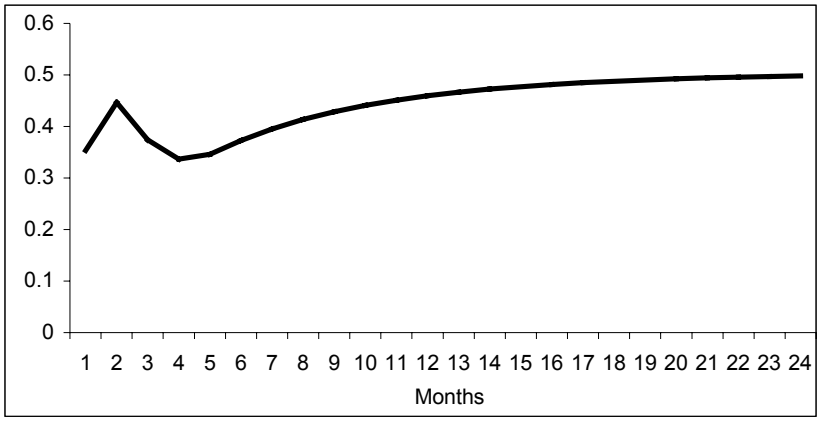

Figure 4.1.2 Impulse Response of Manufacturing Industry Producer Prices to Import Price Shock

These results show that pass-through of import prices into manufacturing industry producer prices is higher than pass-through into consumer prices. This is not surprising, because Turkish manufacturing industry imports have the highest share in imports. This indicates that the share of the tradable components in production is higher than consumption. Therefore, import price developments are expected to affect pricing behavior of producers significantly. In the consumption basket, however, existence of non-tradable items and administered prices[50] decreases the sensitivity of consumer prices to import price developments. The results here confirm McCarthy (2000) that pass-through declines along the pricing chain.

[50] Non-tradable items mostly consist of items under services classification. For administered items, tobacco products are a good example.

Impulse response functions give information about the speed of pass-through as well. It is found that import price pass-through into consumer prices is quicker than import price pass-through into manufacturing industry prices. That is to say, while 90 percent of the cumulative pass-through into consumer prices is completed within 6 months, it takes almost one year for manufacturing industry producer prices. A possible explanation may be that the import prices are reflected on consumer prices mostly through direct channels rather than indirect channels. The prices of energy items such as petroleum, natural gas are determined by automatic adjustment mechanism[51] and they account approximately 5 percent[52] of consumption basket as of 2009. Therefore, the pass-through of these items on consumer prices is direct and immediate. On the other hand, for manufacturing industry the speed of pass-through may be slower amid factors like long-term contracts that guarantee more stable prices, relatively higher inventories and pricing-to-market effects.

4.1.2 Impulse Responses to Exchange Rate Shock

Figure 4.1.3 and Figure 4.1.4 display the estimated pass-through into consumer prices and manufacturing industry producer prices following a one percent shock to exchange rate. Responses of other variables to exchange rate shock are presented in Appendix Figure A.3. In this model, the exchange rate shock is estimated given past values of all endogenous variables in addition to the current value of output gap.

[51] Automatic price adjustment mechanism determines prices of items subject to this system according to formula. This formula takes into account international price and exchange rate developments in price determination. The formula is calculated on daily basis for petroleum products, on monthly basis for natural gas and on quarterly basis for electricity prices.

[52] This is author's approximation, not the exact weight.

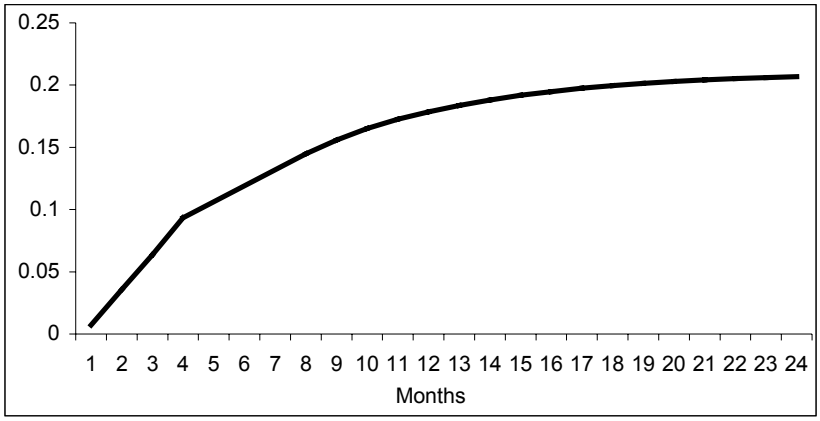

Figure 4.1.3 Impulse Response of Consumer Prices to Exchange Rate Shock

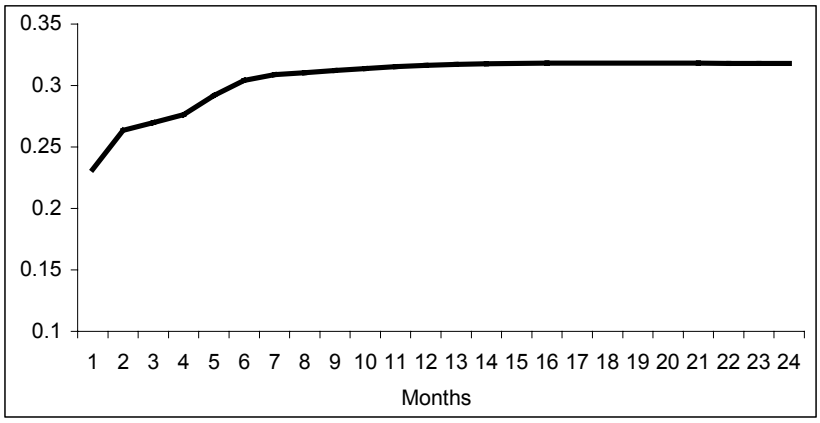

Figure 4.1.4 Impulse Response of Manufacturing Industry Producer Prices to Exchange Rate Shock

The response of consumer and producer prices to a one percent increase in exchange rate[53], like in import price shock, is positive as expected. Figure 4.1.3 shows that the immediate effect of depreciation on consumer prices is very low. However, the extent of exchange rate pass-through tends to rise over time. The estimated pass-through coefficient is 18 percent at the end of the first year and amounts to approximately 21 percent at the end of the

[53] Increase in exchange rate refers to depreciation of TL against USD.

forecast horizon. On the other hand, manufacturing industry producer prices respond more than consumer prices to a one percent increase in exchange rate. The immediate response is approximately 23 percent and at the end of the first year it becomes 32 percent (Figure 4.1.4). In the second year, the change in cumulative pass-through becomes negligible.

The pass-through of exchange rate into manufacturing industry producer prices is not only higher but also faster than it is for consumer prices. In a time span of 5 months, 92 percent of cumulative pass-through into manufacturing prices is realized and in a year the pass-through is almost complete. On the other hand, 86 percent of cumulative pass-through into consumer prices is completed in a year and the rest is completed the following year.

The comparative analysis of the results regarding the extent of pass-through states that the response of manufacturing industry producer prices to each shock is higher than the response of consumer prices. This verifies decreasing pass-through of external shocks into price indicators along the distribution chain. However, the responses of price indicators to external shocks differ from each other as far as speed of pass-through concerned. More specifically, although cumulative import price pass-through into manufacturing industry producer prices is higher than cumulative exchange rate pass-through, exchange rate shocks are passed-through faster than import price shocks into manufacturing industry producer prices. On the contrary, exchange rate pass-through into consumer prices is much slower than import price pass-through into consumer prices, albeit the magnitudes of cumulative pass-through of both shocks into consumer prices are almost the same. These observations show clearly that the pass-through dynamics of external shocks in Turkey are different from each other. This proves that inserting exchange rate and import prices as a composite variable into the model like in Kara and Öğünç (2008) hides particular impact of each external shock and hence, prevents capturing the true pass-through dynamics. This

justifies the validity of inserting external shocks separately into the VAR model.

The pass-through results concerning the manufacturing industry indicate that firms are more prone to reflect changes in import prices to their prices compared to changes in exchange rate. This may be correlated with the weight of each factor in the production process. That is to say, import prices may comprise a larger share of the production cost of firms than exchange rate. In addition, firms may have more opportunity to hedge themselves against possible exchange rate fluctuations compared to import price fluctuations. On the other hand, volatility and persistency characteristic of shocks may be another explanation. More volatile and less persistent characteristic of exchange rate compared to import prices may result in lower pass-through for exchange rate, as firms may behave more eager to adjust mark-ups rather than adjust prices following such exchange rate behavior.[54]

The pass-through results of external shocks into consumer prices reveal that the cumulative pass-through of both shocks is almost the same. However, it seems that the channels that import prices affect consumer prices contain more direct effects than exchange rates. It makes sense, as the goods directly affected from import prices (mostly energy items) has a larger share in consumption basket than the goods, the price of which is set in foreign currency (high-tech electronic devices). High level of inventories may be considered as another factor reducing the reflection of exchange rates in that period.[55] As for manufacturing industry producer prices, increasing persistency of import price changes may reduce the tolerance to resist these shocks and may lead to immediate changes, while exchange rate changes

[54] A comprehensive analysis on volatility and persistency of external shocks is given in Section 4.4.

[55] Such effect is observed after October 2008 on automobiles prices. High level of car inventories in Turkey helped firms resist the exchange rate shock and prevented them to reflect that shock fully into their prices.

behave in a more unpredictable manner, causing retailers to follow a wait and see policy.

4.2 Variance Decomposition

Although the impulse responses shed light on the extent and the speed of pass-through to domestic price indicators, they do not specify the importance of shocks in domestic price fluctuations. Therefore, investigating the importance of shocks would complement the response analysis and yield a complete understanding of the pass-through characteristics in Turkey. Variance decomposition gives insight on importance of external shocks as it decomposes variations in price indicators into the shocks to the endogenous variables in the VAR model.

Figure 4.2.1 and Figure 4.2.2 summarize the results of the variance decompositions of consumer prices and manufacturing industry producer prices over a forecast horizon of 24 months. For the sake of clarity, only the contributions of exchange rate and import price shocks are reported.[56]

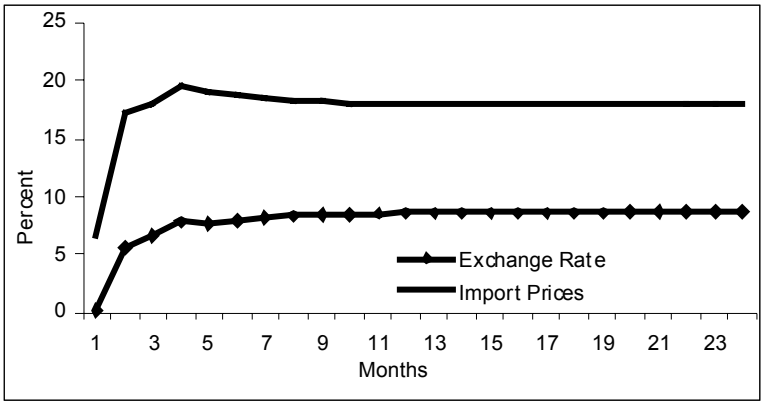

Figure 4.2.1 Variance Decomposition of Consumer Prices

[56] The complete variance decomposition of the manufacturing industry producer prices and CPI can be found in Appendix Table A.1 and Table A.2

With regard to the variance of consumer prices, external shocks are important determinants, while import prices account more than exchange rate for the variation in consumer prices. Initially, external factors account for about 6 percent of the variance, the majority of which comes from import prices. As the forecast horizon increases, the contribution of both exchange rate and import prices increase, which amounts up to 25 percent (Figure 4.2.1).

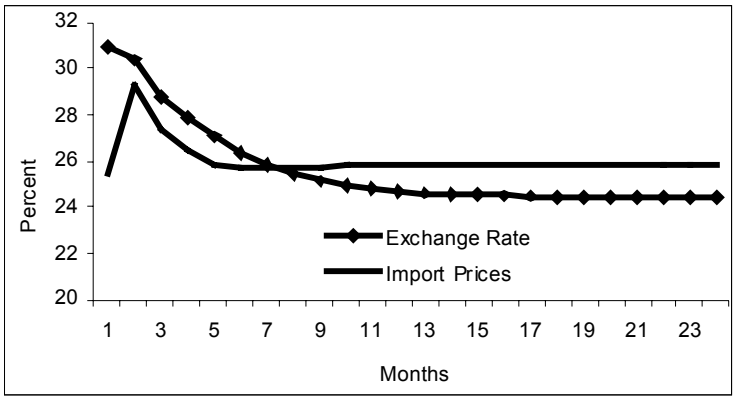

Figure 4.2.2 Variance Decomposition of Manufacturing Industry Producer Prices

Exchange rate shocks seem more import for the variation of manufacturing industry producer prices in the short-run. However, as forecast horizon increases, import prices contribute relatively more to the variation, although contributions of both external factors fall in level terms (Figure 4.2.2).

To sum up, external factors explain a large fraction of the variance of both consumer and manufacturing industry producer prices. Among the external factors, import prices are more important than exchange rates for the variation of price indicators in the long run. In addition, the impacts of external shocks on the variance of the price indices decrease along the distribution chain, while this decrease is higher for exchange rates.

4.3 The Sensitivity of Estimation Results to Different Ordering

The results derived from VAR models may strongly depend on the underlying identification scheme or the period the model is estimated. In this section, the robustness of the results of the baseline model is examined only under a different identification scheme. A robustness analysis based on using different sample periods is ruled out in this thesis, as the sample size is not big enough to make a decent periodical comparison and the periodical comparison has already been done by Kara and Öğünç (2008) for Turkish data. They have shown that pass-through has fallen after May 2001 in Turkey. These factors rule out the necessity of a robustness analysis based on estimation periods.

Economic theory allows several ordering on contemporaneous relationship between the variables, therefore any economically plausible ordering of the variables is possible. The choice of the ordering depends highly on how the relationship between variables is perceived. To recall, in the baseline model the ordering is output gap, exchange rate, import prices, manufacturing industry producer prices and consumer prices.

A plausible change in the ordering of variables may involve the change in the location of output gap variable. Unlike the baseline model, this alternative ordering suggests locating the output gap variable after external shocks to allow for contemporaneous impact of all external shocks (exchange rate and import prices) on output gap. As a result, the ordering of variables becomes nominal exchange rate, import prices, output gap, manufacturing industry producer prices and consumer prices.

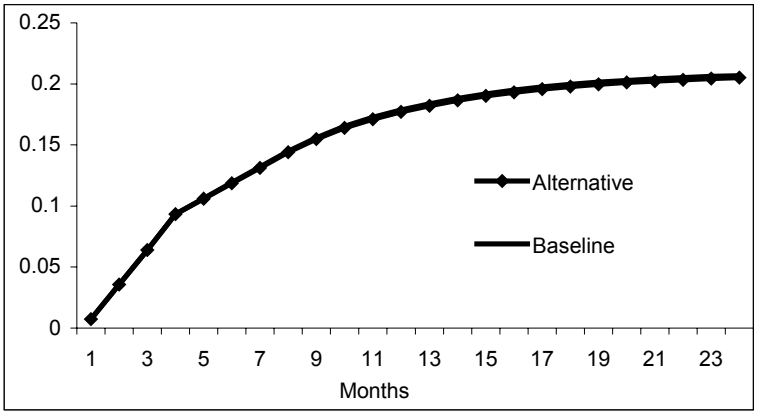

Figure 4.3.1 Impulse Response of Consumer Prices to Exchange Rate Shock under Alternative Scenario

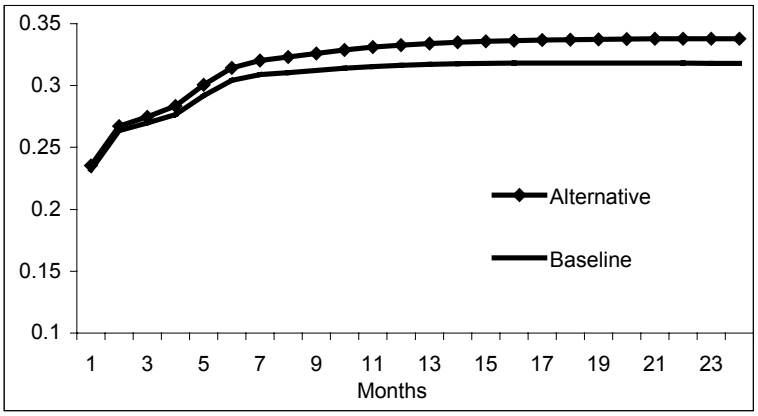

Figure 4.3.2 Impulse Response of Manufacturing Industry Producer Prices to Exchange Rate Shock under Alternative Scenario

Figures 4.3.1 to 4.3.4 shows the comparison of the impulse response functions of manufacturing industry producer and consumer prices to exchange rate and import price shocks under baseline model and the alternative ordering. The impulse responses of manufacturing industry producer prices and consumer prices to each external shock are robust across different orderings. None of the changes seems significant in size. Among the small changes, the most obvious difference is observed in the response of manufacturing industry producer prices to exchange rate shock.

The response of consumer prices to exchange rate, on the other hand, is almost the same with baseline model.

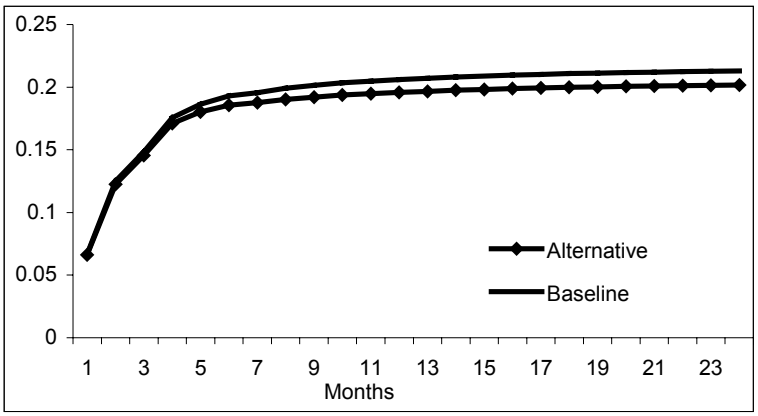

Figure 4.3.3 Impulse Response of Consumer Prices to Import Price Shock under Alternative Scenario

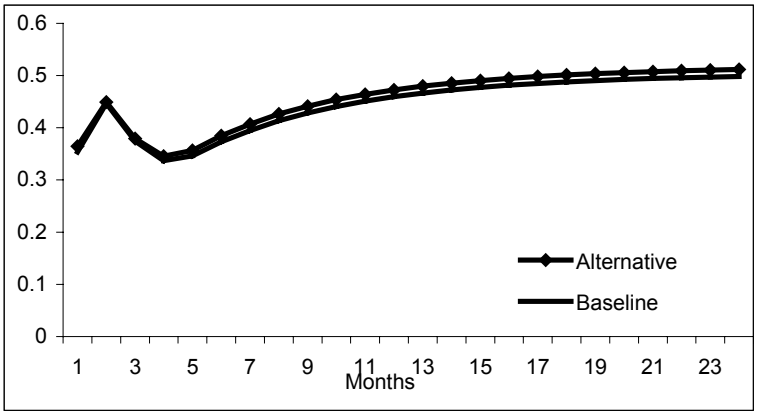

Figure 4.3.4 Impulse Response of Manufacturing Industry Producer Prices to Import Price Shock under Alternative Scenario

4.4 The Comparison of Results with Previous Studies

This thesis has attempted to estimate the pass-through of external shocks into price indicators with the latest data available. Therefore, comparison of the results of this thesis with the results of previous studies enables

assessing the evolution of pass-through dynamics in Turkey. However, it is important to note that the definitions of the shocks, the models used in the analyses and the variables inserted into the respective models show some dissimilarity among the studies. Nevertheless, the common points may help compare the results with each other.

The exchange rate pass-through results show that exchange rate pass-through has significantly fallen over time in Turkey. This is valid for both producer and consumer prices. Leigh and Rossi's (2002) calculations point out that the cumulative exchange rate pass-through is 45 percent and 60 percent for consumer and producer prices, respectively. However, the corresponding coefficients are found 21 percent and 32 percent in this thesis. On the other hand, in both studies it is found that pass-through into producer prices is more pronounced compared to pass-through into consumer prices.

Considering the import prices, none of the studies employed to Turkish data uses a definition of import prices similar to the one used here. Even if the studies include an import price variable, TL-denominated import prices is preferred. Therefore, it becomes impossible to make an exact comparison of import price pass-through results with other studies. However, combination of exchange rate and import price pass-through results here may allow to make a comparison with pass-through results of Kara and Öğünç (2008), as their exchange rate definition is, in fact, imported inflation, i.e. inflation resulting from either exchange rate or import prices.

In Kara and Öğünç (2008), imported inflation pass-through under the IT is calculated to be 30 percent for consumer prices and 50 percent for manufacturing industry prices. To make the comparison, harmonization of results is required. Accordingly, it needs calculating a weighted average of exchange rate and import price pass-through coefficients of this thesis. However, it is beyond the scope of this thesis to determine the relative importance of exchange rate and import prices in such calculation. Thus,

exact weights cannot be assigned to pass-through coefficients. Nevertheless, the results can be evaluated in an interval.

It is obvious that any linear combination of import price and exchange rate pass-through into consumer prices takes value around 21 percent. On the other hand, for manufacturing industry prices, possible outcomes can take values between 32 and 50 percent. These possible intervals conclude that imported inflation pass-through in this thesis is lower than Kara and Öğünç (2008) find.

Comparison of results has revealed that pass-through has weakened not only after the introduction of IT as the new monetary policy regime but also during IT. There may be several explanations on this outcome, but change in volatility and persistency of external shocks and lower inflation environment achieved during IT seem to be the most explanatory factors.

It is discussed in Section 2.1 that as the volatility of shocks increases, the degree of pass-through falls (Taylor, 2000). The results of the volatility analyses[57] show that the decreasing pass-through period coincides with the increase in the volatility of external shocks. Figure 4.4.1 shows that exchange rate volatility increased during free-floating regime compared to fixed exchange rate regime excluding the elevated volatility during the 2001 crisis and shortly afterwards. In addition, the volatility under the floating exchange rate regime has also increased recently.

[57] To measure volatility, standard deviation of percentage change of the respective variable on a rolling basis is preferred.

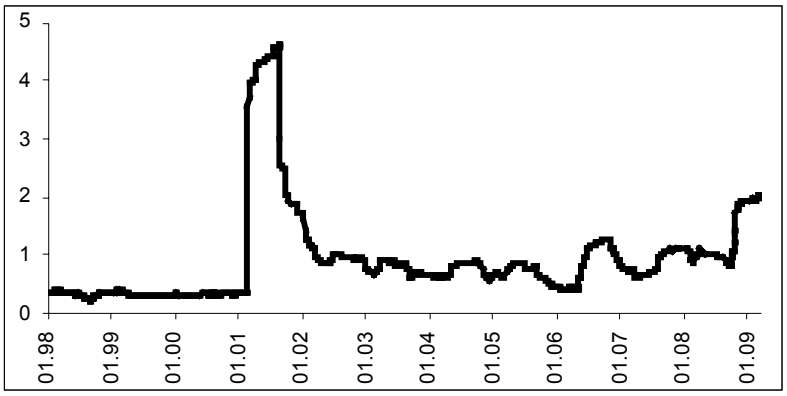

Figure 4.4.1 The Volatility of Exchange Rate

Considering the volatility of import prices, the results are not as clear as exchange rate, since volatility follows a changing pattern, albeit it has significantly increased lately (Figure 4.4.2). To sum up, increasing volatility may have influenced the decrease in pass-through.

Figure 4.4.2 The Volatility of Import Prices

Change in the persistency of external shocks may be another determining factor for the pass-through effects. Recall that, persistency has a direct relationship with the degree of pass-through (Taylor, 2000; McCarthy, 2000). In order to evaluate the persistency of exchange rate and import prices, two different methods are used. The first one is to check the significance of the sum of the autoregressive AR (12) coefficients on lagged variables of changes in the respective variable, as shown in equations [4.1] and [4.2]

below. The sum of autoregressive coefficients ($\Sigma\rho_i$) as a measure of persistence is proposed by Andrews and Chen (1994) and is a common measure used in the literature. It is related to the speed with which changes in respective variable converges back to its baseline value following a shock.

$$\pi_t^{imp} = \alpha + \sum_{i=1}^{12} \rho_i \pi_{t-i}^{imp} + \varepsilon_t^{imp} \qquad [4.1]$$

$$\Delta e_t = \beta + \sum_{i=1}^{12} \rho_i \Delta e_{t-i} + \varepsilon_t^{e} \qquad [4.2]$$

The persistency of exchange rate and import prices are calculated for both sample period and pre-sample period so as to grasp the change in the persistency of variables across periods.[58] The estimations show that exchange rate exhibits a highly persistent characteristic in the pre-sample period, while this persistency disappears in the sample period. Conversely, import price inflation is non-persistent before the sample period, while in the sample period it shows significant persistency. However, given the relatively short sample period, the statistical power of these tests might be relatively low (Cecchetti and Moessner, 2008). Therefore, it is better to crosschek the results with another persistency measure, such as transition probabilities, so that a firm conclusion on persistency is attained.

Transition probabilities analysis gives similar results to the preceding method. It indicates that in the pre-sample period, 84.5 percent of the time, in monthly terms depreciation of TL was followed by depreciation (Table 4.4.1).[59] This

[58] Pre-sample period covers data between January 1994 and March 2002. Sample period is April 2002 to March 2009.

[59] The data is considered to have a discrete state and parameter spaces. The parameter space is divided into equal lengths of one month and each month corresponds to one step. State space is divided as increase or decrease which shows the direction of the change in the variables. For example, at Table 4.4.1, 26.80 indicates that between January 1994 and March 2002 26.8 percent of the time an increase in import prices in the current month is followed by a decrease in the next month.

reveals that the period is characterized by persistent upward movements in exchange rates. This characteristic weakens in the sample period, as appreciations and depreciations follow each other more frequently. This significant change in exchange rate behavior might have lowered the exchange rate pass-through, as it makes difficult to foresee whether exchange rate changes are permanent or transitory.

Table 4.4.1 Transition Probabilities: January 1994 – March 2002

	Exchange Rate		Import Prices	
	Decrease	Increase	Decrease	Increase
Decrease	5.15	5.15	21.65	27.84
Increase	5.15	84.54	26.80	23.71

Considering import prices, transition probabilities do not give an unambiguous conclusion until 2002, but in the sample period it shows significant persistency as in monthly terms 45.8 percent of the time an increase was followed by an increase and 17.9 percent a fall was followed by a fall (Table 4.4.2). This change in persistency behavior of import prices may lead firms to reflect import price shocks more than they do for exchange rate shocks. This may be an answer to why import price shocks have a higher pass-through than exchange rate into manufacturing industry producer prices and why import price pass-through is quicker than exchange rate pass-through into consumer prices.

Table 4.4.2 Transition Probabilities: April 2002 – March 2009

	Exchange Rate		Import Prices	
	Decrease	Increase	Decrease	Increase
Decrease	38.10	20.24	17.86	17.86
Increase	20.24	21.43	19.05	45.24

Volatility and persistency analysis explain much of the change in pass-through behavior, but lower inflation environment sustained under IT may be another factor. As Taylor (2000) asserts, the general inflationary environment

affects pass-through and under low inflationary environments, the pass-through is lower.

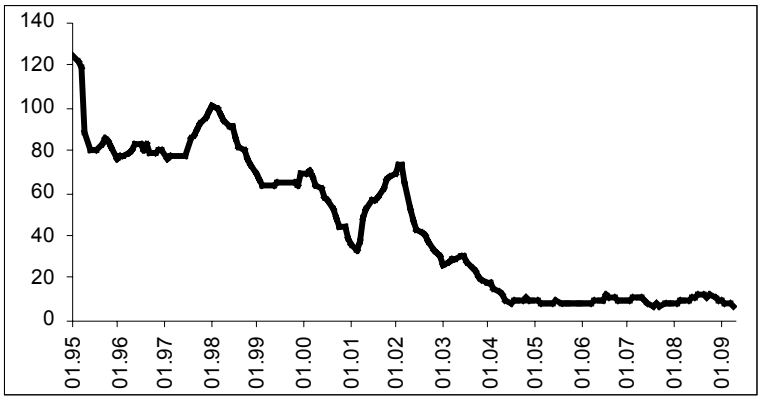

Figure 4.4.3 Annual Consumer Inflation

Figure 4.4.3 shows clearly that shortly after the beginning of IT, annual inflation rates fell significantly below its historical levels and in the last few years the rates have sustained levels just below 10 percent. Note that the estimation periods of previous studies correspond to years when the inflation was fairly high. Therefore, it seems that a lower inflation environment sustained in the last few years may have contributed to decrease in the magnitude of pass-through.

CHAPTER 5

INFLUENCE OF EXTERNAL SHOCKS ON CONSUMER INFLATION

This section presents a brief summary of the inflation developments in Turkey under IT, which has been adopted following the collapse of the stabilization program based on a crawling exchange rate peg in February 2001. Additionally, it aims to identify the role of external factors on inflation and question explanations of the CBRT on divergence of inflation from pre-defined year-end targets due to external shocks. In this regard, a static analysis based on the information derived from the impulse response functions is utilized.

5.1 Inflation Outlook under Inflation Targeting

After the collapse of the stabilization program based on a crawling exchange rate peg in February 2001 CBRT switched to a new monetary policy regime to end long-lasting chronic inflation problem in Turkey. This new regime, which also involved implementing a floating exchange rate, was called "inflation targeting" (IT).[60] However, the conditions after the 2001 crisis were creating substantial obstacles to implement a complete IT program. Accordingly, CBRT decided to pursue a gradual switch to IT so that preconditions for a more effective monetary policy would be satisfied during the transition period. Inflation developments during the IT period are presented in the following subsections.

[60] Kara and Orak (2008) present a comprehensive analysis on inflation targeting experience of Turkey.

5.1.1 Implicit Inflation Targeting Period

At the beginning of IIT regime, the annual inflation in Turkey was as high as 68.5 percent. In the first year of IIT, CBRT's target was to bring inflation down to 35 percent, but annual inflation fell even further to 29.7 percent at the end of 2002. In the following years, both targets and realizations followed a declining trend and each year realizations were below targets (Figure 5.1.1).

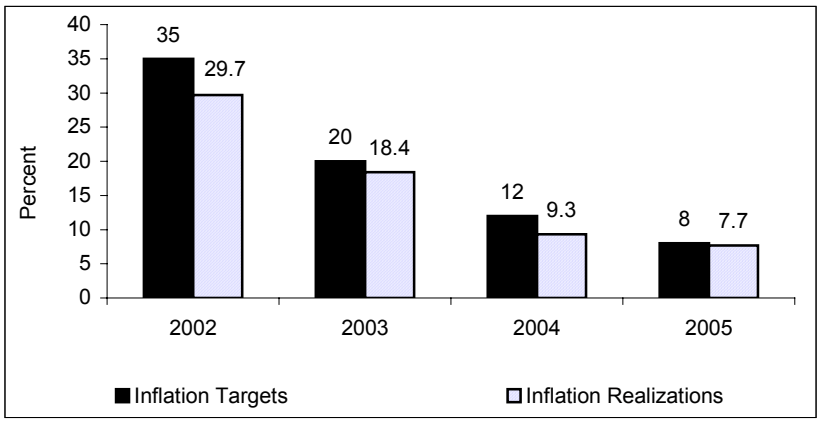

Figure 5.1.1 Inflation Targets and Inflation Realizations

CBRT attributed this achievement to the structural improvements made during this period, which enhanced the effectiveness of monetary policy. These improvements include decreasing fiscal dominance, falling risk premium, lower dollarization, increasing central bank credibility, change in formation of expectation and decrease in pass-through (Kara and Orak, 2008).

Although not widely articulated, especially exchange rate developments during this period contributed to downward trend in inflation. Figure 5.1.2 shows the contribution of exchange rate[61] movements to monthly inflation figures during IIT period. It is seen that after mid 2003, except a short period in 2004, exchange rate had always affected consumer inflation in a favorable way. Note that, the lowest annual inflation realization under IIT achieved in 2005 and this year corresponds to the period that exchange rate had continuously decreasing impact on inflation.

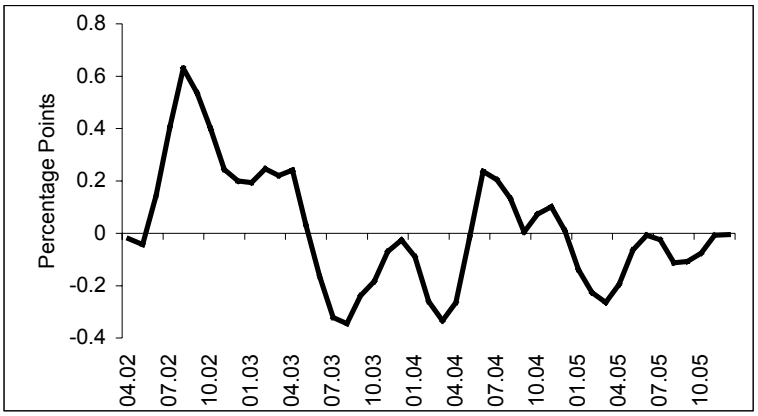

Figure 5.1.2 The Contribution of Exchange Rate Changes to Monthly Consumer Inflation

5.1.2 Full-Fledged Inflation Targeting Period

The success under IIT encouraged policy makers to set more ambitious targets on inflation, however, constant fall in annual inflation during IIT did not continue into FFIT. The inflation targets were set as 5, 4 and 4 percent, respectively for 2006, 2007 and 2008. However, the corresponding realizations were 9.7, 8.4 and 10.1 percent, respectively (Figure 5.1.3). CBRT addressed long-lasting external shocks that hit Turkish economy

[61] The contribution of exchange rate to a month is calculated in the following way: First, the change in the exchange rate in a month is multiplied by the coefficients derived from impulse response function of consumer prices to exchange rate for each month. In this way, marginal contribution of each change to the following 24 months is found. Then, the total contribution of exchange rate for a specific month is calculated as the sum of the values found in the first step corresponding to that specific month.

during this period as the excuse for overshooting the targets. These shocks were exchange rate jump in 2006 and the rise in import price during 2007 and 2008.

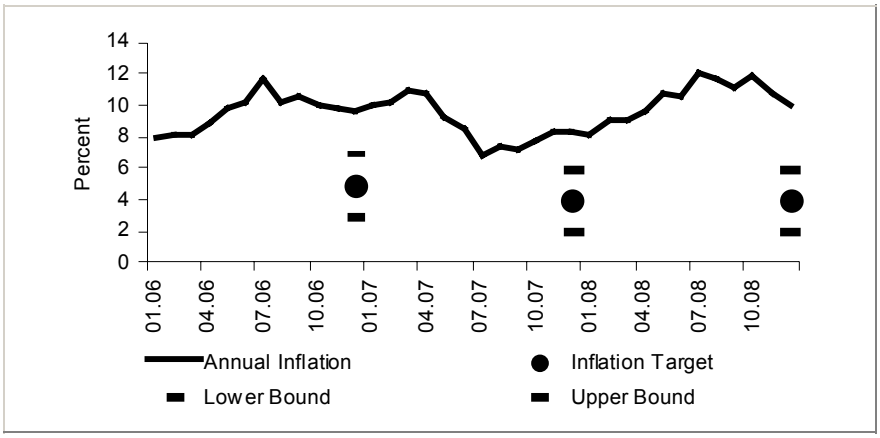

Figure 5.1.3 Annual Consumer Inflation and Inflation Targets

Beginning from May 2006, risk perceptions began to change due to the deterioration in liquidity conditions in global financial markets. Higher global risk aversion has triggered capital outflows in many emerging markets such as Turkey, Hungary and South Africa. The fact that these developments coincided with changes in regional risk perceptions and a higher level of short-term TL assets in the portfolios of non-residents exacerbated fluctuations in financial markets. Consequently, Turkey has witnessed a sudden deterioration in the credit risk premium by around 150 basis points[62] during May and June 2006 and the TL depreciated vis-à-vis the USD by more than 20 percent in the meantime. CBRT responded to these developments with a strong monetary tightening in order to limit the direct and indirect reflections of this shock on consumer inflation. In June and July, policy rates were raised by a total of 425 basis points.

[62] Risk premium is measured by the EMBI spread.

That depreciation of TL against USD resulted in an increase in 2006 inflation. CBRT, in Inflation Report 2007-I, stated the effects of increasing exchange rate on headline inflation in 2006 as follows:

> The cumulative exchange rate pass-through since May has added around 3.5 percentage points to the headline inflation, in line with our projections laid out in July Inflation Report. This effect, coupled with the impact of former supply-side shocks, kept the inflation rate at high levels…thereafter; the end-year inflation for 2006 was realized well above the target (p.1).

The tight monetary policy stance taken by CBRT after 2006 exchange rate shock began to show its impact on economic activity and on inflation in 2007. Economic activity slowed down on the demand side and on the inflation side, annual inflation fell down to 6.9 percent in mid-2007. These developments until July 2007 were consistent with the framework that CBRT has drawn to bring inflation down to medium-term targets. However, in the second half of 2007, another external shock began to hit the Turkish economy on the supply side. This time the shock was an import price shock, which originated as a result of rise in global commodity prices. In fact, commodity prices were on the rise since 2006 and besides the exchange rate, creating an additional inflationary pressure on 2006 inflation through food and energy prices. However, beginning from mid-2007, rise in import prices intensified and turned into a more persistent phenomenon, such that for 11 consecutive months between September 2007 and August 2008 import prices increased and cumulative increase summed up to 40 percent in this period.

The inflation figures, in this period, also had an upward trend. After its lowest level in July 2007, the consumer inflation was again higher than inflation target at the end of 2007. CBRT, in Inflation Report 2008-I, summarized the factors on inflation developments in 2007 as follows:

> Elevated prices of crude oil, agricultural products and other commodities have continued to exert inflationary pressures all over the world. Recently, both the developed and emerging economies have been facing a rise in inflation… The fall in headline inflation, however, was more limited, owing mainly to factors beyond the control of monetary policy, such as developments in food, energy, and administered prices. Accordingly, inflation was 8.39 percent at the end of 2007, breaching the upper bound of the uncertainty band (pp. 1-2).

The inflation outlook worsened in 2008 compared to 2007. The annual inflation increased to 12 percent during the year. In order to manage the inflation expectations and keep them consistent with its medium-term target, CBRT began to put more emphasis on core indicators, which excludes the items import prices affect directly. This would make easier to make a judgment on the main inflation trend. However, core indicators also rose due to indirect effects of the shock. CBRT preferred a tightening in monetary policy to restrict the indirect effects, however, the inflation did not seem to slow down. CBRT eventually decided to change the inflation targets to more realistic levels, as the older targets seemed no longer attainable.[63] After August 2008, the increasing trend turned upside down with incipient global economic crisis and severe falls in import prices. In total, annual inflation in 2008 was the highest since 2004. Central Bank evaluated 2008 developments in its Inflation Report 2009-I in the following manner:

> Inflation in 2008 was largely determined by developments in the global economy. After sharp increases in energy and other commodity prices in the first three quarters, there has been a dramatic shift in inflation dynamics in the last quarter. With the intensification of the global financial crisis, commodity prices have displayed a sharp reversal as the global loss of confidence led to a significant slowdown in the world economic activity. Accordingly, there has been a marked fall in domestic energy and processed food inflation in the last quarter. Yet, cumulative past increases in the

[63] See "Open Letter Written to the Government About Inflation Targets Persuant to Article 4 of the Central Bank Law" for detailed information.

> commodity prices have kept annual inflation at relatively high levels. Around 6.2 percentage points of the 10.1 percent annual CPI inflation in 2008 can be explained by the direct impact of the increases in food and energy prices (p.1).

5.2 The Pass-Through Exercise

The brief summary presented in Section 5.1 shows that CBRT addressed external shocks for not achieving the year-end targets under FFIT. This section questions the explanations of CBRT in its policy notes and investigates whether external shocks in this period really affected the inflation as CBRT have proposed so far. Therefore, this section presents an exercise on external shocks and their effect on inflation with a static analysis based on the results obtained from impulse response functions in Section 4.1.

5.2.1 Exchange Rate Shock on the 2006 Inflation

To identify the extent of how the depreciation affected inflation, realized inflation path has to be compared with a hypothetical inflation path under a scenario. In this scenario, exchange rate is held constant after April 2006 until the end of the year. The marginal contribution of exchange rate shock to each month is subtracted from the realized values and a new inflation path is constructed with the new monthly changes.

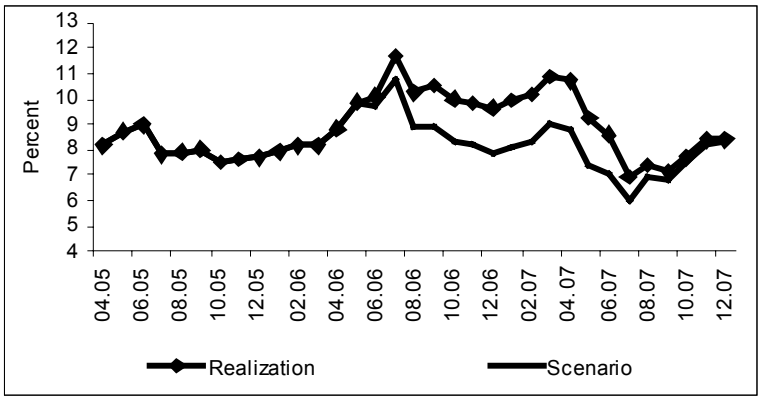

Figure 5.2.1 Annual Consumer Inflation Path excluding Exchange Rate Shock in 2006

According to this analysis, exchange rate shock has contributed to the 2006 annual inflation around 1.8 percentage points. In other words, even if an exchange rate shock had not occurred, the annual consumer inflation would have been 7.85 percent in 2006. This level, apparently, is still higher than the inflation target of 5 percent set for 2006 and, thus, CBRT still misses the target albeit with a smaller margin. It also breaches the upper limit of the uncertainty band around the target, which would make CBRT to explain the reasons of missing the targets under the accountability framework (Figure 5.2.1). The graph also illustrates that impact of exchange rate shock on annual inflation continued into 2007, but vanished as 2007 came to an end.

It is clear that the estimations presented here and that of CBRT are considerably different from each other. According to CBRT, inflation would have fallen inside the uncertainty band around the target if exchange rate shock had not hit the economy. Nevertheless, the point target would not have been attained. However, the result of this study is not consistent with the explanation of CBRT. This diversification between findings may be attributed to some factors.

To start with, given the information set about the extent and the speed of pass-through, the results are eventually determined by what the coefficients are multiplied with. Therefore, how the rate of depreciation is defined is of

utmost importance for the analysis. The ratio of exchange rate at peak level during the shock to its value before the shock or monthly average exchange rate changes before and after the shock may be considered as two alternatives to measure the rate of depreciation. The first choice may exaggerate the extent of depreciation by including information on very temporary movements. On the other hand, the latter may smooth the changes in exchange rate and downgrade the extent of the shock in question.[64] In this exercise, the latter is taken as the measure of depreciation in order to be consistent with the specification of the VAR model. Another explanation may rest on the econometric modeling of pass-through analysis. A VAR model, which is estimated by a recursive estimation procedure, may fall short in reflecting the exact conditions during 2006, since it reflects an average characteristic of the sample period rather than reflect a particular time period. And in Section 4.4, by comparative analysis of the results, it is justified that pass-through structure have changed over time. Therefore, the coefficients obtained in this thesis may underestimate the impact of exchange rate shock on inflation. In order to have a period-specific pass-through result, the model had to be estimated on a rolling basis, but the small sample size would not allow for reliable results in such case.

A difference in the definition of exchange rate shock may be another factor. CBRT may have defined exchange rate shock as the imported inflation shock as in Kara and Öğünç (2008).[65] When the behavior of import prices at the same period is investigated, it is estimated that import prices also contributed to 2006 inflation approximately by 1.6 percentage points. Therefore, the sum of the impact of external shocks on inflation period amounts roughly to 3.4

[64] The exchange rate increased up to 1.70 TL/USD, which corresponds to a 30 percent depreciation compared to the exchange rate just before the shock. However, the peak level lasted only 2 days and the exchange rate fell immediately back to levels, which correspond to a depreciation of 20 percent.

[65] The authors are employees of CBRT and the earlier version of the study was published as a CBRT Working Paper in 2005. See Kara and Öğünç (2005) for the earlier version.

percentage points, which is close to CBRT's calculation of 3.5 percentage points.

To sum up, although the pure exchange rate pass-through calculations are different from each other, the definition of depreciation, how the depreciation rate is measured and the factors affecting the extent and the speed of pass-through over time may lead to this diversification. However, both CBRT and the results here reach the same conclusion that the inflation target of 5 for 2006 had not been attainable even if there were no adverse exchange rate developments.

5.2.2 Import Price Shock on the 2007 and 2008 Inflations

To identify the impact of import prices on consumer inflation in 2007 and 2008, the same analysis framework as in Section 5.2.1 is used. In this case, the level of import prices is held constant at its June 2007 level. According to this analysis, import prices had significant impact on inflation figures both in 2007 and 2008. The calculations show that the rise in import prices in the second half of 2007 contributed to the 2007 inflation by 1.8 percentage points. In other words, if import prices had not increased, the year-end inflation would have been approximately 6.5 percent. This level is again substantially higher than the 2007 target of 4 percent. However, it is also important to note here that in November 2007, changes in administered prices contributed inflation around 1 percentage point.[66] This means that if factors outside CBRT's control had not happened, inflation would have been around 5.5 percent at the end of 2007. Although this level is still 1.5 percentage points higher than the target, it falls within the uncertainty band. In this situation, CBRT would not have given account to public for

[66] See Inflation Report 2008-I of CBRT for details.

overshooting the target. To conclude, in 2007 CBRT was right to address import prices and administered prices for missing the year-end targets.

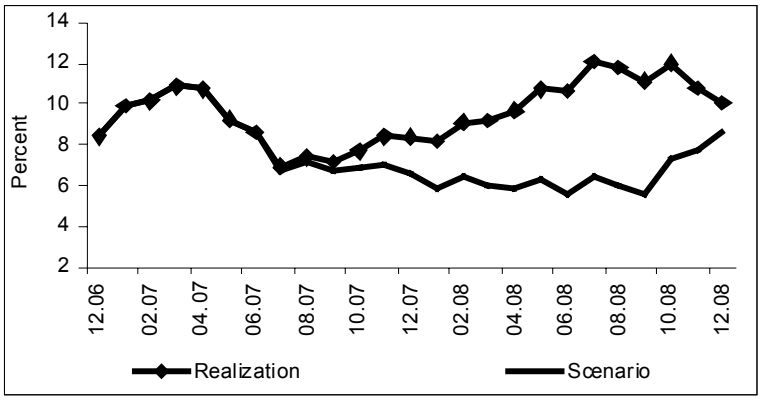

Figure 5.2.2 Annual Consumer Inflation Path excluding Import Price Shock in 2007 and 2008

In 2008, the calculations display that the impact of import prices on annual inflation is significantly higher compared to 2007. Figure 5.2.2 shows the difference between annual inflation realizations and the annual inflation path under the scenario. The difference, as clearly seen, is increasing gradually until August, and it amounts approximately to 5.8 percentage points. This means that without an import price shock annual inflation would have fluctuated between 5.5 percent and 6.5 percent until October 2008.[67] This band, like in 2007, is above the 2008 target of 4 percent but very close to fall within the uncertainty band around the target. This again justifies the arguments of CBRT on missing the inflation target in 2008.

On the other hand, after October 2008, there is an increase in the annual inflation in the scenario. This stems from the exchange rate depreciation in October 2008, because, the alternative scenario only excludes the contribution of import price developments, not the exchange rate. However, annual inflation realizations do not reflect this movement. The reason is that fall in import prices offset the possible reflection of depreciation of TL in the

[67] The fluctuations in annual inflation is mostly due to seasonal items in the consumer basket, such as clothing and footwear and unprocessed food.

last quarter of 2008. This argument is also very consistent with the explanations of CBRT who has emphasized frequently in its policy notes that depreciation is not expected to affect inflation significantly.

To crosscheck results of the impact of import price shock on the 2008 inflation, the price developments of items which were affected extensively by this shock could be used. As emphasized in CBRT's policy notes, import prices had direct effects through food and energy prices and had indirect effects through catering and transport services. Actually, food prices are mostly driven by processed food price developments in this period. In Başkaya et.al (2008), the relationship between import prices and processed food prices is clearly depicted. To sum up, changes in annual inflation of processed food, energy, catering services and transport services may be a handful tool to crosscheck import price pass-through results on consumer prices in 2008.

Table 5.2.1 The Contribution of Items to Annual Inflation between June 2007 and August 2008

	Annual Inflation in June 2007[68] (1)	Annual Inflation in August 2008 (2)	Change in Annual Inflation (3)= (2)-(1)	Weight in Consumption Basket[69] (Percent) (4)	Contribution to Annual Inflation (5)=(4)*(3)/100
Processed Food	9.45	25.5	16.05	14.1	2.27
Energy	5.28	27.38	22.1	14	3.10
Catering Services	10.53	15.44	4.91	5.02	0.25
Transport Services	11.97	16.4	4.43	4.04	0.18

Recall that calculations based on information from impulse response functions showed that between June 2007 and August 2008 import prices

[68] The inflation rates of energy and processed food are taken from issues of Monthly Price Developments (CBRT) for the corresponding months. Inflation rates of catering and transport services are taken from TURKSTAT database.

[69] The weights of catering and transport services are 2008 weights, which are taken from TURKSTAT database. The weights of processed food and energy are approximations of the author, which are derived from Special Consumption Aggregates.

shock contributed to annual consumer inflation by 5.8 percentage points. According to the information in Table 5.2.1, the sum of contribution of each item to annual consumer inflation also points out 5.8 percentage point contribution. This verifies that the results from impulse response functions are similar to realizations.[70]

[70] The exact verification of estimation results with realizations may be a coincidence. Since the degrees of freedom is low due to small sample size and high number of coefficients to estimate, there might be an over-fitting problem in the VAR model. This point should be stressed while interpreting the accuracy of results.

CHAPTER 6

CONCLUSION

In this thesis, pass-through of import prices and exchange rate into consumer and manufacturing industry producer prices are analyzed. The analysis is based on a VAR approach including the distribution chain of pricing. In the baseline model, identification is achieved through a standard Cholesky decomposition. Information on the size and the speed of the pass-through is derived from impulse response functions. Variance decomposition is used to assess the relative importance of external shocks on prices at different stages. Robustness of the results is tested by a different ordering of the variables.

The results indicate that the cumulative pass-through of exchange rate and import prices into consumer prices is almost the same, although import price changes are transmitted quicker than exchange rate changes. On the other hand, manufacturing industry producer prices response to import prices more than exchange rate. Compared with the previous studies, findings point out that the pass-through has declined recently in Turkey. This change in the pass-through behavior may be attributed to the change in volatility and persistency structure of the external shocks plus the lower inflation environment sustained during IT regime. Variance decompositions signify that external shocks account for quite large fractions of the variance in all price indices. On the other hand, results are found to be robust to different ordering in the Cholesky decomposition. Almost identical results as regards the responses of the different price indices to external shocks were derived.

The calculations based on the information derived from impulse response functions conclude that external shocks had unfavorable impact on 2006,

2007 and 2008 annual inflations. To quantify, exchange rate jump in 2006 contributed to the 2006 inflation by 1.8 percentage point. On the other hand, import price shock beginning from mid-2007 had increased 2007 inflation by 1.8 percentage point. The ongoing impact of this shock reached 5.8 percentage point during 2008.

Results of the pass-through analysis show that external shocks still have a considerable influence on price indicators in Turkey, albeit this influence lessened recently compared to the earlier periods. Therefore, in order to attain the inflation targets, CBRT has to take into account the developments in factors outside of its control seriously and grasp the reflection of such shocks into inflation indicators precisely. In this regard, this thesis presents valuable information on recent pass-through dynamics in Turkey and findings can be used as a tool in the inflation analysis.

This research can be developed in several ways. First of all, the analysis conducted in this paper refers to aggregated consumer price indices. In order to investigate which items in the consumption basket are more affected by external shocks, distinguishing it as goods and services or tradable and non-tradable would be beneficial. Alternatively, pass-through into core inflation indicators may be examined to focus on indirect effects of external shocks on inflation. This would give an insight on how the main trend of inflation is affected by factors outside the control of CBRT. Secondly, small sample size limits the number of variables that could be included into the model. As time passes on, with a larger sample size, variables capturing the monetary side of the economy can be added to the model. In this way, the reaction of monetary policy to external shocks may also be identified. Lastly, the same analysis can be executed with a different methodology instead of a linear VAR model. A non-linear model can improve the identification of the relationship between variables in the system. Alternatively, utilizing a threshold VAR would enable to identify whether pass-through into price

indicators show asymmetry with the direction of the change in the respective shocks.

REFERENCES

Alper, K. (2003) Exchange Rate Pass-Through to Domestic Prices in the Turkish Economy. *Master's thesis, Department of Economics, Middle East Technical University*, Ankara.

Andrews, D., Chen, H-Y. (1994) Approximately Median-unbiased Estimation of Autoregressive Models. *Journal of Business and Economic Statistics,* Vol. 12, No. 2, 187-204.

Arat, K. (2003) Choice of Optimum Exchange Rate Regime in Turkey and an Analysis of Exchange Rate Pass-Through. *Expert Report, Central Bank of the Republic of Turkey*, Ankara.

Arbatlı, E. (2003) Exchange Rate Pass-Through in Turkey: Looking for Asymmetries. *Central Bank Review 3*, No. 2, 85-124.

Atuk, O. (2009) How Has the Seasonal Behavior of Consumer Prices Changed in the Last Decade, *mimeo.*

Başkaya, Y. S., Gürgür, T., Öğünç, F. (2008) İşlenmiş Gıda Fiyatlarını Belirleyen Faktörler, *Research and Monetary Policy Department Working Paper*, No. 08/09.

Bernanke, B. S. (2006) Energy and the Economy, Speech delivered Before the Economic Club of Chicago, Chicago, Illinois.

Burstein, A., Eichenbaum, B., Rebelo, S. (2002) Why is Inflation So Low After Large Devaluations?, *NBER Working Paper*s, No. 8748.

Campa, J. M., Goldberg, L.S. (2002) Exchange Rate Pass-through into Import Prices: A Macro or Micro Phenomenon?, *NBER Working Papers,* No. 8934.

CBRT. Inflation Report 2007-I.

CBRT. Inflation Report 2008-I.

CBRT. Inflation Report 2009-I.

CBRT. Monetary and Exchange Rate Policy for 2008.

CBRT. Monthly Price Developments.

CBRT. Open Letter Written to the Government About Inflation Targets Persuant to Article 4 of the Central Bank Law.

Cecchetti, S. G., Moessner, R. (2008) Commodity Prices and Inflation Dynamics. *BIS Quarterly Review*, December 2008.

Choudhri, E. U., Hakura, D. S. (2001) Exchange Rate Pass-Through to Domestic Prices: Does the Inflationary Environment Matter?, *IMF Working Paper*, No. WP/01/194.

Devereux, M. B., Yetman, J. (2002) Price Setting and Exchange Rate Pass-Through: Theory and Evidence, *HKIMR Working Paper,* No. 22/2002.

Dornbusch, R. (1985) Exchange Rate and Prices, *NBER Working Paper*, No. 1769.

Duma, N. (2008) Pass-Through of External Shocks to Inflation in Sri Lanka, *IMF Working Paper,* No. WP/08/78.

Enders, W. (2004) *Applied Econometric Time Series*, 2nd Edition, Wiley.

Faruqee, H. (2004) Exchange Rate Pass-Through in the Euro Area: The Role of Asymmetric pricing Behavior, *IMF Working Paper,* No. WP/04/14

Fernandez, R. B. (1981). A Methodological Note on the Estimation of Time Series. *Review of Economics and Statistics*, 63, No. 3, 471–476.

Frankel, J., Parsley, D., Wei, S. (2005) Slow Passthrough Around the World: A New Import for Developing Countries?, *KSG Working Paper*, No. RWP05-016.

Goldberg, P., Knetter, M. (1997) Goods Prices and Exchange Rates: What Have We Learned?, *Journal of Economic Literature,* Vol. 35, 1243-1272, September.

Hahn, E. (2003) Pass-Through of External Shocks to Euro Area Inflation. *European Central Bank Working Paper Series*, No. 243.

Hampton, T. (2001) How Much Do Import Price Shocks Matter for Consumer Prices?, *Reserve Bank of New Zealand Working Paper*, No. DP2001/6.

Irandoust, M. (2000) Exchange Rate Pass-Through in the Automobile Industry, *The International Trade Journal*, Vol. 14, No. 1, 37-51.

Ivanov, V., Kilian, L. (2002) A Practitioner's Guide to Lag-Order Selection for VAR Impulse Response Analysis, *CEPR Discussion Papers*, No. 2685.

Kara, A. H. (2006) Turkish Experience with Implicit Inflation Targeting, *Research and Monetary Policy Department Working Paper,* No. 06/03, Central Bank of Turkey.

Kara, A. H., Küçük Tuğer, H., Özlale, Ü., Tuğer, B., Yücel, M. E. (2007a) Exchange Rate Regimes and Pass-Through: Evidence from the Turkish Economy, *Contemporary Economic Policy*, Vol. 25 (2), 206-225.

Kara, A. H., Orak, M. (2008) Enflasyon Hedeflemesi, *Books and Booklets,* Central Bank of Turkey, Retrieved in August 2008, http://www.tcmb.gov.tr/yeni/iletisimgm/kara_orak.pdf

Kara, A. H., Öğünç, F. (2008) Inflation Targeting and Exchange Rate Pass-Through: The Turkish Experience, *Emerging Markets Finance and Trade,* November-December 2008, Vol. 44, No. 6, 52-66.

Kara, A. H., Öğünç, F., Özlale, Ü., Sarıkaya, Ç. (2007b) Estimating Output Gap in a Changing Economy, *Southern Economic Journal*, Vol. 74 (1); 269-289.

Karadaş, E., Mutluer, D., Barlas Özer, Y., Aysoy, C. (2008) Türkiye'de İmalat Sanayindeki Firmaların Fiyatlama Davranışı, *İktisat İşletme ve Finans,* Vol. 23, No. 268, 7-34.

Krugman, P. (1987). Pricing to Market When the Exchange Rate Changes in Real Financial Linkages Among Open Economies, ed. by Arndt, S. W and Richardson J. D., Cambridge, Massachusetts: MIT Press, 49-70.

Leigh, D., Rossi, M. (2002) Exchange Rate Pass-Through in Turkey, *IMF Working Paper*, No. WP/02/204.

Liu, L., Tsang, A. (2008) Pass-Through Effects of Global Commodity Prices on China's Inflation: An Empirical Investigation, *China & World Economy*, November-December 2008, Vol. 16, No. 6, 22-34.

McCarthy, J. (2000) Pass-Through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialized Economies. *BIS Working Papers*, No. 79.

Mishkin, F.S. (2007) Headline versus Core Inflation in the Conduct of Monetary Policy, Speech delivered At the Business Cycles, International Transmission and Macroeconomic Policies Conference, HEC Montreal, Montreal, Canada.

Murray, J. (2008) Some Puzzles Related to Exchange Rate Pass-Through, Prepared for a conference hosted by University of Bologna at Rimini, Italy, draft version.

Öğünç, F., Kara, A. H. (2005) Exchange Rate Pass-Through in Turkey: It is Slow, but is It Really Low?, *Research Department Working Paper*, Central Bank of Turkey.

Pollard, P. S., Coughlin, C. C. (2004) Size Matters: Asymmetric Exchange Rate Pass-Through at the Industry Level, *University of Nottingham Research Paper*, No. 2004/13.

Sims, C. (1980) Macroeconomics and Reality, *Econometrica,* Vol. 48, 1-49.

Sims, C., Stock, J., Watson, M. W. (1990) Inference in Linear Time Series Models with Some Unit Roots, *Econometrica,* Vol. 58, 113-144.

Taylor, J. B. (2000) Low Inflation, Pass-Through, and the Pricing Power of Firms, *European Economic Review*, Vol. 44, 1389 – 1408.

Warr, Peter. (2008) The Transmission of Import Prices to Domestic Prices: an Application to Indonesia, *Applied Economics Letters*, Vol. 15, No. 7, 499-503.

APPENDIX

Figure A.1 The Residual Graphs of the Baseline VAR Model

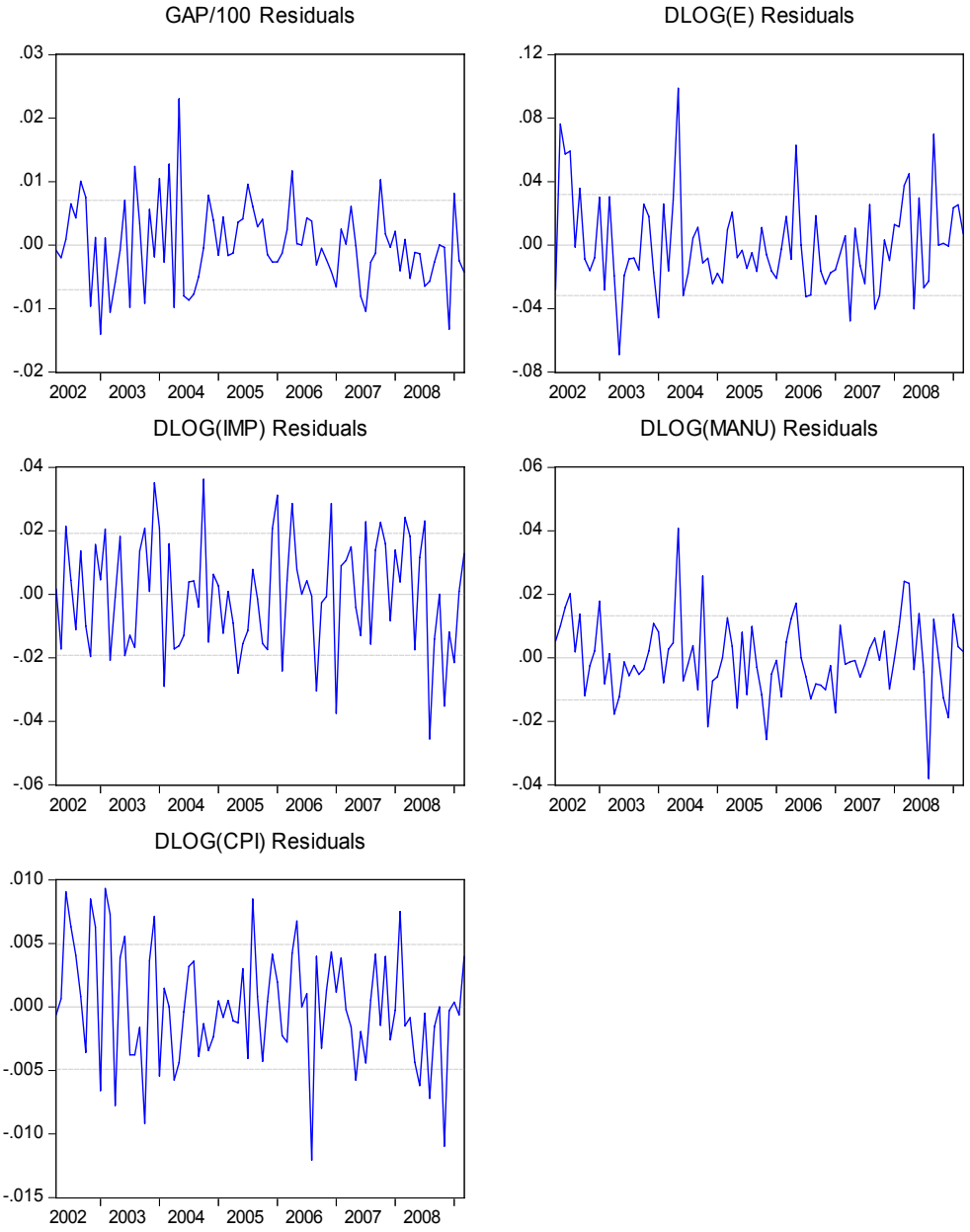

Figure A.2 Accumulated Impulse Response of Endogenous Variables to Import Price Shock

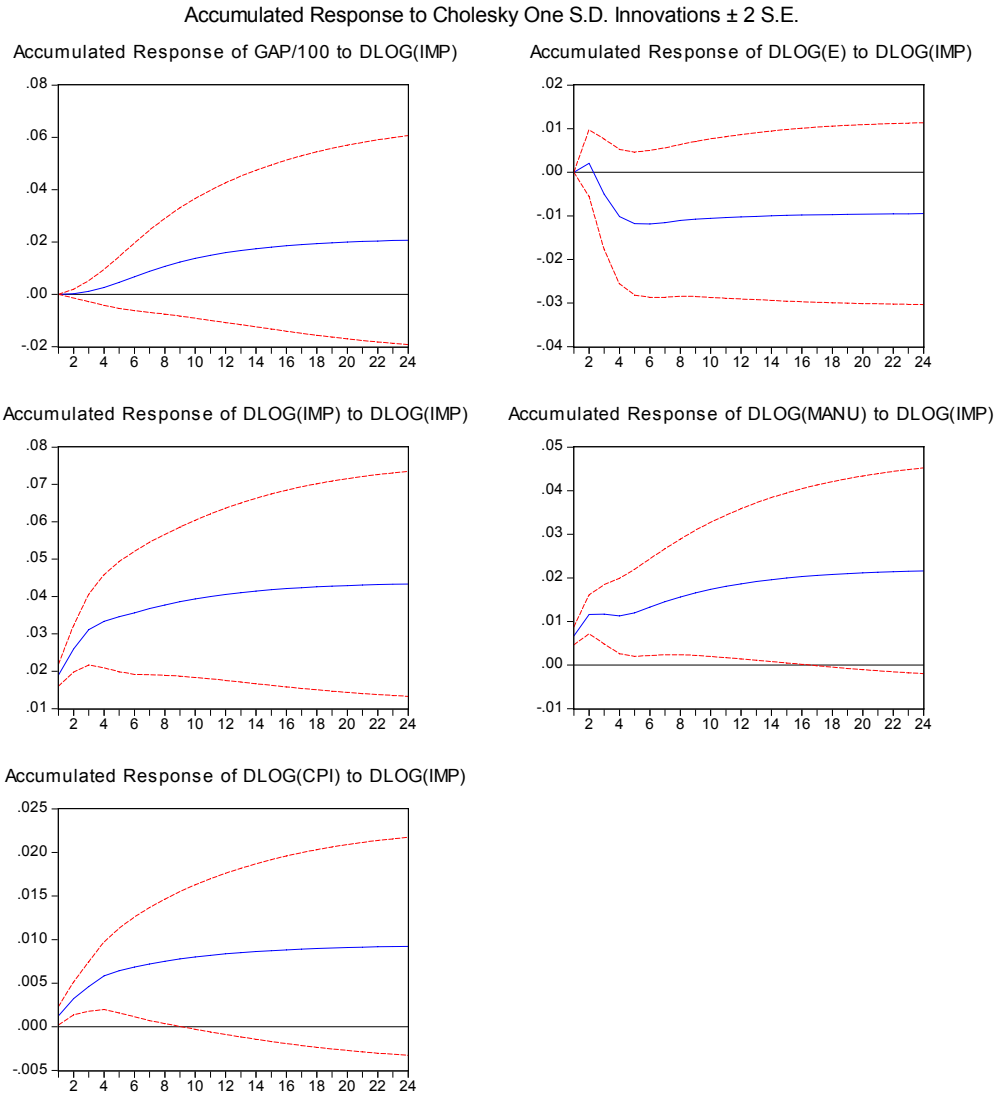

Figure A.3 Accumulated Impulse Response of Endogenous Variables to Exchange Rate Shock

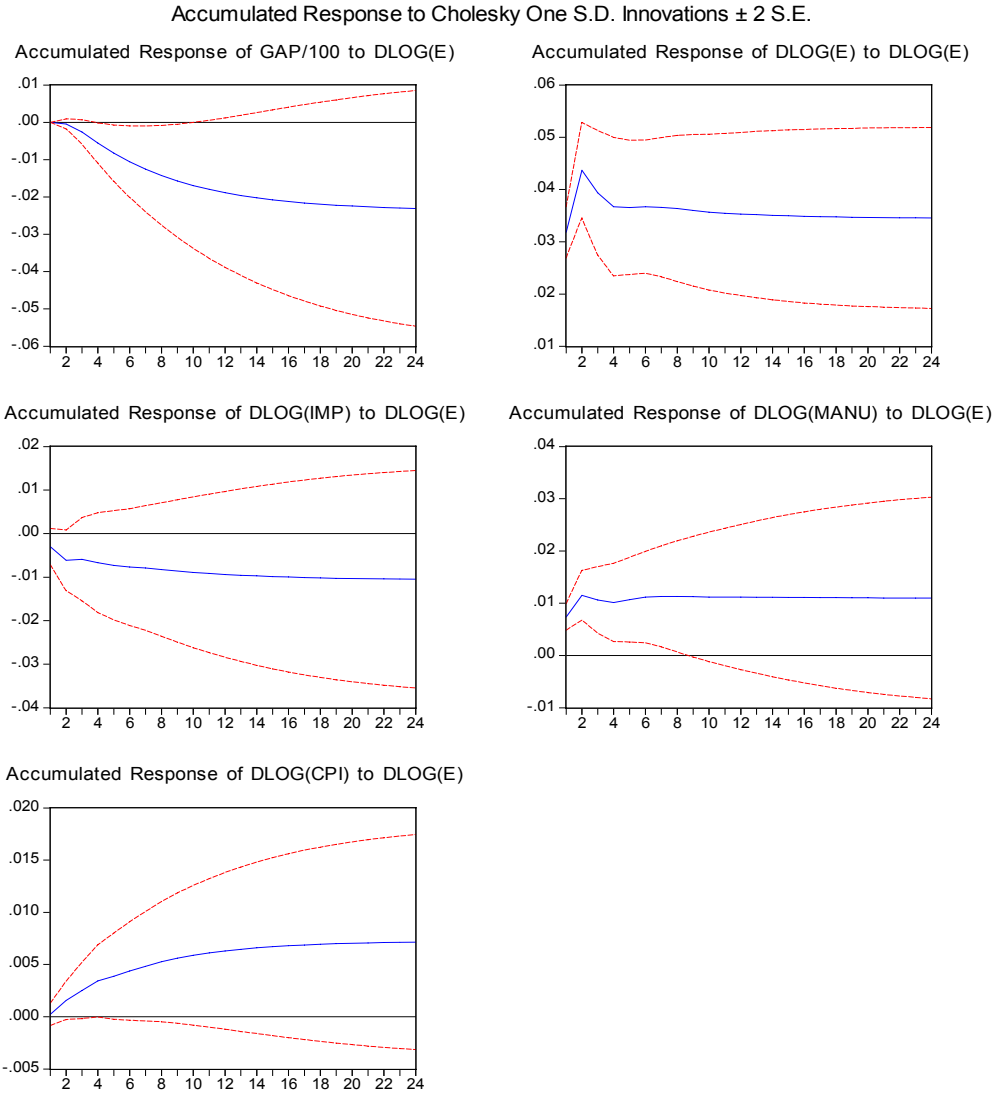

Table A.1 Variance Decomposition of Consumer Price Index

Period	S.E.	GAP	DLOG(E)	DLOG(IMP)	DLOG(MANU)	DLOG(CPI)
1	0.00	0.00	0.22	6.63	3.01	90.13
2	0.01	0.00	5.62	17.10	2.27	75.00
3	0.01	0.20	6.62	18.03	7.63	67.52
4	0.01	0.23	7.81	19.63	8.80	63.53
5	0.01	0.24	7.72	19.05	10.17	62.83
6	0.01	0.26	7.94	18.76	10.44	62.60
7	0.01	0.26	8.12	18.43	10.62	62.57
8	0.01	0.26	8.33	18.28	10.68	62.45
9	0.01	0.25	8.43	18.16	10.78	62.37
10	0.01	0.25	8.50	18.09	10.85	62.31
11	0.01	0.25	8.54	18.04	10.90	62.28
12	0.01	0.25	8.56	18.01	10.93	62.25
13	0.01	0.25	8.58	17.98	10.95	62.24
14	0.01	0.25	8.59	17.97	10.97	62.22
15	0.01	0.25	8.60	17.96	10.98	62.21
16	0.01	0.25	8.60	17.95	10.99	62.21
17	0.01	0.25	8.60	17.95	11.00	62.20
18	0.01	0.25	8.61	17.94	11.00	62.20
19	0.01	0.25	8.61	17.94	11.00	62.19
20	0.01	0.25	8.61	17.94	11.01	62.19
21	0.01	0.25	8.61	17.94	11.01	62.19
22	0.01	0.25	8.61	17.94	11.01	62.19
23	0.01	0.25	8.61	17.94	11.01	62.19
24	0.01	0.25	8.61	17.94	11.01	62.19

Table A.2 Variance Decomposition of Manufacturing Industry Producer Price Index

Period	S.E.	GAP	DLOG(E)	DLOG(IMP)	DLOG(MANU)	DLOG(CPI)
1	0.01	6.32	30.98	25.48	37.22	0.00
2	0.02	4.88	30.39	29.28	32.93	2.51
3	0.02	5.29	28.79	27.43	32.90	5.59
4	0.02	6.44	27.89	26.55	32.23	6.89
5	0.02	7.53	27.07	25.87	31.29	8.24
6	0.02	8.41	26.39	25.76	30.50	8.94
7	0.02	9.11	25.82	25.73	30.07	9.26
8	0.02	9.57	25.43	25.75	29.82	9.43
9	0.02	9.87	25.15	25.77	29.64	9.57
10	0.02	10.08	24.95	25.79	29.50	9.68
11	0.02	10.24	24.81	25.80	29.39	9.75
12	0.02	10.36	24.71	25.82	29.31	9.80
13	0.02	10.45	24.63	25.83	29.26	9.84
14	0.02	10.52	24.58	25.83	29.22	9.86
15	0.02	10.56	24.54	25.84	29.19	9.88
16	0.02	10.60	24.51	25.84	29.16	9.89
17	0.02	10.62	24.49	25.84	29.15	9.90
18	0.02	10.64	24.47	25.85	29.14	9.90
19	0.02	10.66	24.46	25.85	29.13	9.91
20	0.02	10.67	24.45	25.85	29.12	9.91
21	0.02	10.68	24.45	25.85	29.12	9.91
22	0.02	10.68	24.44	25.85	29.11	9.91
23	0.02	10.69	24.44	25.85	29.11	9.91
24	0.02	10.69	24.44	25.85	29.11	9.91